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EDITORIAL

With the publication of the current issue, the *Indian Forester* enters into 109th year of its existence. On this occasion, we take this opportunity of wishing a very happy and prosperous new year to all our readers, subscribers, contributors, patrons and others associated with the advancement and welfare of this journal.

During the past year we were fortunate to receive a number of valuable suggestions from many of our readers and patrons who have taken keen interest in this prestigeous publication. We have not been able to accomplish every thing suggested but are trying to publish material so that the journal could serve the cause of forestry better. We sincerely hope that during the current year the *Indian Forester* will faithfully cover important national topics and thrust areas of forest management and research.

O.N. Kaul

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THE INDIAN FORESTER

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FORESTRY FOR THE RURAL POOR

K M. TIWARI

President

Forest Research Institute & Colleges, Dehra Dun

The year 1982 has been a year of great challenge to Indian foresters. Due to increasing population pressure, there is an unprecedented demand particularly for firewood which has led to the degradation of all such forests which happen to situate in the vicinity of the villages or urban population. Foresters have been generally blamed for this state of affairs. While it is admitted that foresters might not have been able to protect such forests, the fact remains that by and large forest areas which happen to be situated away from the village habitations have still been maintained in fairly good condition. This is borne out by the latest assessment carried out by F.A.O. (Tropical Forest Resources of Asia – 1981) wherein it has been shown that even now we have in our country about 61 million ha of closed forests out of the total forest area of 75 million ha.

An indepth study indicates that the onslaught on the village forests of the country has been due to reasons beyond the control of the Forest Department. This is borne out from the fact that while in 1950, the net area sown under agriculture used to be 118 million ha, it has now reached to 145 million ha. Of this only 2.5 million ha have been formally transferred from the reserved forests. The balance of 24 5 million ha represents generally the tree growth of one kind or the other which used to be classified in revenue papers either as culturable wasteland or as miscellaneous tree lands and groves. These areas were controlled either by the Revenue Department or by the local communities. The extension of agriculture has been affected mainly by clearing these areas. These were the forests which used to supply the day to day requirements of firewood, leaf fodder, small timber and a variety of raw material for local cottage industries for the conventional communities. The clearance of these forests has, while on the one hand created all the scarcity regarding availability of firewood etc. in the villages, on the other hand it has led to the degradation of the environment.

In the Himalayan region where foresters are being made responsible for the degradation of the tree vegetation, again the facts are just otherwise. The areas in the Himalayan region,

particularly in Uttar Pradesh which have been recently made treeless, are mostly the Civil and Soyam forests, a category of forest which were put under revenue administration where even now the District Collector continues to be *ex-officio* Conservator of Forests. The revenue authorities did not work these forests under working plans which resulted in their gradual disappearance. The reserved forests too in the hilly areas situated in the vicinity of villages have been degraded due to the pressure of an increasing human population and grazing.

We have to recognise the fact that in hilly areas forests and the people are inseparable. It is for the foresters to manage the forests for the benefit of these people. What is required at the moment is to raise plantations around the villages in as short a time as possible with no consideration whether the land is reserved forest or Civil and Soyam area. What is of greater importance is that small patches of 4-10 ha of such forests are raised in the immediate vicinity of the villages with close cooperation of the people for their sole use and where we may have enlightened village people who can manage such forests themselves; the Forest Department should not hesitate to hand them over for management.

If any village community is prepared to do the planting themselves, seeds, plants, technical knowhow and even some monetary help needs to be provided by the Government. Similarly individuals desirous of planting trees on their private lands should be given all governmental support, and if they happen to be small farmers entire planting cost should be borne by the Government.

Wherever such forests are to be managed by Department, the work of the officers will be only managerial, i.e. they will provide the villagers with all available forest produce from these forests. If such an approach is adopted there is no reason why even in the hills we might not be able to carry out our afforestation activity with success.

In the plains of North India where canal system is being practised for the last 150 years, the gradual disappearance of village forests during the past three decades has created the problem of water logging and formation of alkali lands. The trees used to act as biological pumps. These canals and their distributaries generally run on the watershed line passing through loose soil. As such quite a large amount of water passes on either side by seepage. In most of the places the system of irrigation has been by flow method where more water than necessary is applied to the crops. This too results in evaporation of water from the fields in the dry seasons. This has added to the problem of alkali formation. So long as small village forests were present in these areas they acted as biological pumps and prevented the formation of alkali soils and also helped in keeping the area free from water logging. With these village forests gone, a greater damage to the good agricultural areas is also taking place in the country-side particularly where canal irrigation is being practised. This has led to decreasing yield from agricultural fields which is sought to be compensated by bringing in more area under plough. Let us not forget that in our country the highest percentage of area (about 46%) is under agriculture and our production per ha per annum continues to be one of the lowest – less than 1 ton per ha per annum. Our neighbouring country, China is reported to produce 4 tons per

ha per annum. Obvious solution to tackle the problem may be to line the canal system with cement so that the seepage is stopped and to irrigate the fields by the sprinkler method. But both of these solutions are highly capital intensive and in the present state of our economy, it may not be possible to take them up. Another solution could be to raise multiple line of trees along the canals to prevent the seepage and to raise lines of trees in and around the irrigated fields to pump out the extra water given to the fields at the time of flow irrigation. Besides this, all other areas getting degraded by *usar* formation, if they could be planted up with trees like *Prosopis* spp., *Terminalia arjuna*, *Pongamia pinnata*, *Madhuca latifolia*, *Azadirachta indica* etc., a large quantity of water which is otherwise damaging the existing soil is likely to be pumped out.

The gradual disappearance of village forests covering about 24.5 million ha in the country-side, the diversion of more than 4 million ha of reserved forests to agriculture, reservoirs, canals and other uses and degradation of a part of the reserved forest area situated along the villages and towns due to excessive grazing and expolitation by the people mainly for firewood, have let loose the destructive elements of nature. The annual floods and drought, the increasing wind storms, accelerated soil erosion and change in rainfall pattern have now opened the eyes of policy makers, planners and administrators. They have now realised that environmental degradation is mostly because of large scale deforestation. Foresters on the other hand have been pleading since the beginning of Second Five Year Plan for large scale afforestation activity not only in the reserved forest areas but also in the village community lands, in the vacant strips along roads, canals and rail track to meet the day to day demands of the villagers in respect of firewood, leaf fodder, grass, small timber etc. One may see the paper entitled "Forestry in the Second Five Year Plan" (*Indian Forester*, Vol. 82, No. 3, 1956). Had the programmes envisaged in this paper been taken up, the picture of the country would have been different. But probably we needed the present day disaster to awaken us to take to tree planting on a massive scale. Indeed so serious has been the realisation of environmental degradation by our policy makers, that during 1982 a separate Department of Environment was established by the Central Government. We hope the new Department of Environment will help the Forest Department in getting more funds for the increased afforestation activity. The Department of Environment has been lately entrusted with the direct responsibility of looking after the wild life also. Wild life constitutes part and parcel of the forest eco-system so this does not, in any way lessens the responsibility of the foresters in respect of wild life.

It is now widely appreciated that if forestry is to play its meaningful role in the national economy, a separate Ministry at the Centre is a *sine qua non*. So long as a separate Ministry of Forests is not established, there is every justification to constitute a separate Department of Forestry in the existing Ministry of Agriculture. Let us hope the Central Government would accede to this long felt need of foresters during 1983.

I do not know if people are aware that whereas during the Sixth Five Year Plan the Central Government and the Planning Commission had approved an outlay of about Rs. 3,400

million for agricultural research and education, for forestry this was only Rs. 120 million i.e. only about 3.5% of the budgetory provision for agricultural research and education, when the total area under forestry is about 1/2 of the area under agriculture. Let us hope during the Seventh Five Year Plan period, at least 1,000 million are allocated for forestry research and education.

It is gratifying that so far as foresters are concerned they have appreciated the problem and in most of the states, Social Forestry programmes have been taken up. In Uttar Pradesh, Social Forestry programme will soon be entering the fifth year and in Gujarat it will be the fourth year of the programme States of West Bengal, Madhya Pradesh, Maharashtra and Tamil Nadu have also taken up Social Forestry programmes in a big way now. Other States are going to take up this programme very soon. It is hoped that, when all these programmes are executed within a decade or so, we shall have turned the corner. It is well-known that the programmes of Social Forestry are basically meant not only for the amelioration of the degraded environment but mainly to meet the day to day requirement of villages regarding firewood, leaf fodder, grass, small timber and a variety of produce for local cottage industries. We have to give a thrust so that the beneficiaries of Social Forestry programme are the people living below the poverty line.

Energy plantations is one of the latest thrusts in plantation forestry. Any tree raised, where there were no trees before, entraps solar energy and constitute an energy plantation. But in the past due to budgetary constraints, we have been raising only about 1000 trees/ha. To make our plantations capable of producing maximum biomass we should go in for close planting of suitable short rotation firewood yielding trees in mixtuie with conventional long rotation tree species. Spacing may be as close as 1 m × 1 m and then resort to thinnings as often as possible on yearly, two-yearly or three-yearly cycles so as to produce firewood on a sustained basis. Trees of leguminous species like *Leuceana, Acacias, Albizzias,* etc. should be planted in the inter-spaces of the main line of tree species at close spacing wherever possible; among other benefits it will act as bio-fertilizer and will ensure optimum productivity.

May I quote here the message of the Prime Minister when she addressed the State Forest Ministers Conference on 18th October 1982. ....''Perhaps you remember Gandhiji's saying that when any major decision is to be taken we should recalls the face of 'Daridranarayan'......'. It will be clear that if we observe the above motto, the programmes of Social Forestry are bound to benefit the poor people. In fact the time has come when we should advise our Governments and policy makers to the idea that the entire resources of the forestry including those being created under Social Forestry programmes may be dedicated for the people living below the poverty line. This needs to be incorporated in the new forest policy going to be finalised.

I will request all the readers of the *Indian Forester*, in our country, that they may contribute all their mite to this end and let this be the message for the coming year 1983— "Forestry dedicated to the people living below poverty line".

Unfortunately it so happens that most of the tribals and forest dwellers and villagers living in and around our forest areas happen to be the people living below the poverty line. I, therefore, feel that it should be the special responsibility of the foresters to execute such programmes and to manage the forests in such a way that the income of such people is raised and they are brought above the poverty line within a reasonable period of 5 years or so. This does not appear very difficult, once we decide that the usufructs from the forests are to be utilised for the development of the rural poor. These days, we know that a large population subsists on extracting firewood from our forests. I believe that the extraction of firewood is not at all a work of any pleasure. Those who are doing it are doing so because of economic compulsions. If they could be offered alterantive sources of employment, I am sure they will not take to collection of firewood which in itself is a highly laborious and difficult job. So long as the Government is not able to provide alternative employment to these people, the duty of the foresters should be to plant more trees of shorter rotation in the vicinity of the villages, even if it happens to be reserved forest, and earmark these areas for their use. What is necessary is a well-thought out coordinated planting project. As everybody in the country is now conscious to improve economic status of the people living below the poverty line, the funds required for such a project, I am sure will be made available Already, the Social Forestry programme almost covers this aspect and it is for us to implement it for the benefit of the poor. For example, in the degraded areas of Northern India which has been referred to earlier and where alkalinity has increased and large patches have turned into *usar* lands unfit for productive agriculture, it is quite possible to plant *Terminalia arjuna* and then introduce insects which make tussar cocoons. If this scheme is implemented it is possible to sustain a family of landless on less than a ha of plantation. This has already been achieved in Uttar Pradesh under the Social Forestry Project in more than one centre. There are vast areas where *Terminalia arjuna* plantation can be carried out successfully not only in the degraded areas of the Northern India but also in parts of barren areas of Bihar, Orissa, Andhra Pradesh, Madhya Pradesh and Maharashtra. This has a very high potential for employing the landless people on a sustained basis. Wherever possible the first attempt should be made to get such village forests raised by the communities themselves. Failing which the methodology in the beginning may have to be to plant the trees departmentally, to train the family gradually and then to handover the asset to the family for permanent sustenance of their living. Similar programe of rehabilitating the landless families is possible where better areas are available by growing mulberry trees for producing silk. This is already being done in a large way in Karnataka. It is possible that most of the Northern States and Central States can take full advantage of this item of work for rehabilitation of the landless people.

Similarly dairy industry has a vast potential for employing the landless people. In all suitable areas, planting of fodder trees like *Sesbania, Moringa, Acacia* etc. can be taken up in a big way to provide leaf fodder. Once leaf fodder is available, it should not be difficult to provide milch cattle to the landless families through the other schemes of Intensive Rural Development (IRD) and make them economically sustainable on a permanent basis. It will be necessary to earmark specific areas where fodder trees have been planted so that the user may

have inherent interest in preserving such planted trees and utilising the leaves on a scientific basis so that the trees are not destroyed.

Social Forestry schemes envisage planting of fruit trees like walnut, mango, *Artocarpus integrifolia*, *Zizyphus* sp., *Anona squamosa*, *Aegle marmelos*, *Anacardium occidentale*, *Tamarindus indica*, *Madhuca latifolia*, etc. in suitable areas which will provide nutritious fruit to the poor people. Planting of trees like those of *Salix*, *Moringa*, *Pongamia pinnata*, *Azadirachta indica*, *Madhuca latifolia*, *Morus alba* etc. will produce raw material for a chain of rural cottage industries such as those of basket making, oil extraction, furniture, sports goods, pulp and paper etc. Social Forestry schemes should be treated as an instrument of all round rural development where landless people may be the maximum beneficiaries.

Forest Research Institute & Colleges is laying great stress on the points mentioned above. It is hoped that the new generation of foresters coming out from the Institute will turn the corner. The new probationers and the trainees are being inducted with the dictum that forestry must be dedicated to the people living below the poverty line.

GROWTH OF *LEUCAENA LEUCOCEPHALA*

A.N. CHATURVEDI*

Leucaena leucocephala has been described as a very fast growing Legume. It has been planted extensively all over India in different climatic zones. Chaturvedi (1981) has reported results of these trials in U.P. Trial plantations of this species were made during rains of 1978 at Kukrail near Lucknow. Lucknow has latitude of 27°50′ and longitude of 80°52′. Mean annual rainfall is about 700 mm. The plantations was irrigated frequently. Sample plots were laid in these plantations during April, 1981. The plots were measured on 18.12.81 and again on 24.5.82. The measurements of the two plots are summarised below :

Plot No. 1

Year of Planting : July 1978
Initial Spacing : 2 m × 2 m
Plants per ha : 2500

Period of Measurement

		Unit	14.4.81	18.12.81	24.5.82
(1)	Plants	No./ha	2461	2359	2359
(2)	Av. d.b.h.	cms	8.9	10.7	11.0
(3)	Av. height	m	11.3	13.0	13.2
(4)	Basal area	m^2/ha	15.3	21.7	22.9
(5)	Volume	m^3/ha	51.9	84.7	90.7
(6)	Wood biomass	tonnes/ha	25.9	42.4	45.3
(7)	m.a.i. at	m^3/ha	17.3 3 yrs	24.2 3.5 yrs	22.6 4 yrs
(8)	m.a.i. at	tonnes/ha	8.6 3 yrs	12.1 3.5 yrs	11.3 4 yrs
(9)	Min. d.b.h.	cm	1.8	2.4	4.2
(10)	Max. d.b.h.	cm	14.4	16.7	17.0

*Conservator of Forests Res. & Dev. Circle (U.P.), Lucknow.

Plot No. 2

Year of Planting : July 1978
Initial Spacing : 2 m × 3 m
Plants per ha : 1100

Period of Measurement

		Unit	14.4.81	18.12.81	24.5.82
(1)	Plants	No./ha	1088	1088	968
(2)	Av. d.b.h.	cms	9.5	11 4	11.6
(3)	Av. height	m.	10.8	11.8	12.0
(4)	Basal area	m^2/ha	7.8	11.0	10.2
(5)	Volume	m^3/ha	25.1	38.9	36.9
(6)	Wood biomass	tonnes/ha	12.6	19.5	18.4
(7)	m.a i.	m^3/ha	8.4	11.1	9.2
	at		3 yrs	3.5 yrs	4 yrs
(8)	m.a.i.	tonnes/ha	4.2	5 6	4.6
	at		3 yrs	3.5 yrs	4 yrs
(9)	Min. d.b.h.	cms	2 0	2.3	4.8
(10)	Max. d.b.h.	cms	15.0	18 3	18.8

Note : For converting standing trees to crop volume and wood biomass the following factors were used :

Crop from factor 0.3

Specific gravity of dry wood. 0.5

Analysis of the data shows that the plots which was planted at 2 m×2 m has produced more volume upto the age of 4 yrs. The average growth in diameter and height has not been affected by the spacings at which these plantations were raised. The data is not adequate to determine the rotation of maximum yield.

These plantations were irrigated in the early stages of establishment. These were well protected as these adjoin a research nursery.

Many trees in these plantations are now affected by Gummosis. The mortality in trees in both the plots is due to this disease. The disease has been identified as due to a fungus Fusarium semitectum.

The disease appears as black spots or patches on leaves, pods and stem. Maximum gummosis is noticed in March-April when new growth starts. Affected plants die in about two years. Cutting back of diseased plants produces coppice shoots which show signs of

gummosis in early stages of growth. The species reproduces plentifully from seed and the area in these plots is carpeted with natural seedlings.

SUMMARY

Leucaena leucocephala **has been planted at Kukrail near Lucknow under irrigated conditions. Plantations of 1978 planted at 2m × 2m and 3 m×3 m have given maximum mean annual increment of 11.3 tonnes and 5.6 tonnes respectively. These plantations have been affected due to gummosis.**

ल्यूसेना ल्यूकोकेफाला की वृद्धि

लेखक ए० एन० चतुर्वेदी

सारांश

ल्यूसेना ल्यूकोकेफाला को लखनऊ के निकट कुकरैल में सिंचित दशाओं में रोपा गया है। 2 मी०×2 मी० और 3 मी०×3 मी० पर 1978 में लगाए गए रोपवन से क्रमश: 11.3 टन और 5.6 टन अधिकतम माध्य वार्षिक संवृद्धि प्राप्त हुई है। इन रोपवनों पर गोंदार्ति का भी दुष्प्रभाव पड़ा है।

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A NOTE ON THE *PAULOWNIA* TRIALS—FUTURE HOPE FOR SOCIAL FORESTRY

V.R. NEELAY* AND A.K. SAH

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Paulownia a member of Scrophulariaceae is a naturalized Asiatic, genus. *Paulownia* species are hardy and grow substantially faster on even poor soils, so this property characterises it as an ideal plant for Social Forestry. The present investigation comprised the study of four species of *Paulownia* namely *P. fortunei*, *P. taiwaniana*, *P kawakamii* and *P. tomentosa.*

Seeds were sown in September, 1980 in perforated germination trays containing sterilized sand. The seedlings at the age of two months were transplanted in to the polythene bags of different sizes (25 cm × 10 cm, 25 cm × 13 cm, 25 cm × 16 cm) containing fertile soils. The seedlings of *P. fortunei* and *P. taiwaniana* attained an average height of 10 to 13 cms when transplanted in nursery beds in February, 1981. The average height of other species at the time of transplanting varied from 2.81 to 12.94 cm. Selection of healthy and vigorous individual was necessary in order to prevent disease and pest (Hu, 1974). Experiment consisted of 3 replications. The results were statistically analysed.

All the species exhibited germination except *P. tomentosa* from Alabama. Table 1 indicated that *P. tomentosa* from Kentucky was superior in germination (18 31%) followed by *P. taiwaniana* (16.65%). Statistically average height of *P. taiwaniana* and *P, fortunei* was significant (Table 2). In *P. kawakamii* the germination percentage as well as the growth of the seedlings were very low, therefore, this species was not considered for further trials by transplanting in polythene bags. Plant per cent in *P. fortunei* was 63.14 and in *P. taiwaniana* 49.0 which was better than *P. kawakamii* 20.40 and *P. tomentosa* 11.50.

The sizes of polythene bags had no effect on the growth of seedlings (Table 2), thus *Paulownia* may be successfully raised in narrow polythene bags also. During February, 1981 Agricultrual pest of Soyabeen was recorded on the leaves of *Paulownia* which was controlled with malathion spray.

The authors are thankful to Dr. Ta-wai Hu, Chief Division of Silviculture, Taiwan Forestry Research Institute, Taiwan and to Dr. S.C. Carpenter, Associate Professor, University of Kentucky for supplying the seeds of *Paulownia* species. We are also thankful to Dr. Jamaluddin, S.R.O., Pathology Branch, K.V.A.K , Jabalpur for providing necessary quarantine measures.

*Conservator of Forests, Seoni Circle, Seoni, (M.P.)

Table 1

Species	Source	Qty of seeds (gms)	Germination (%)	No. of seedlings obtained	Plant per cent
P. fortunei	Lukuei Taiwan	1.2	7.02	350	63.14
P. taiwaniana	—do—	1.2	16 60	830	49.00
P. kawakamii	Lishan Taiwan	1.2	5.01	250	20.40
P. tomentosa	Alabama	1.2	—	—	—
P. tomentosa	Middlesboro (Kentucky)	1.2	18.31	913	11.50

Table 2

Species	Average height in centimeters in different sizes of polythene bags on 6.2.82 (5 month old seedlings)		
	25 cm × 10 cm	25 cm × 13 cm	25 cm × 16 cm
P. fortunei	8.75	10 40	12.94
P. taiwaniana	7.75	9.92	6.33
P. tomentosa	2.81	3.18	2.81
SEM ±		5.9	

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EFFECTS OF SPACING AND THINNINGS IN *CASUARINA* STANDS

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Introduction

Casuarina equisetifolia Forst. is very good fuelwood and eminently suited for afforesting the sterile sandy beaches and shifting coastal sand dunes giving high yields even on these infertile soils. An elaborate investigation was started by the Orissa authorities, in consulation with the Central Silviculturist, Forest Research Institute in 1941 in order to determine the influence of initial spacing, subsequent thinning treatment on volume production from *Casuarina* plantation at Balukhand. The Balukhand plantation lies along the sea coast at a distance of 5 to 11 km to the east of Puri town in 85°–50′E, longitude and 19°–48′N latitude. The soil is nothing but pure sand of considerable depth. Being near the sea the climate is equable, hot and humid. The mean annual temperature is about 27°C. The normal rainfall for Puri is 1370 mm, over 60% of which is received during the period mid-June to mid-October.

Design and lay-out of the investigation

Treatments consisted of 9 different combinations of 3 planting espacements (1.83, 2.74 and 3.66 m square) and 3 thinning patterns (no thinning, one semi-mechanical thinning at the age of 10 years and two semi-mechanical thinnings at the age of 7 and 15 years, each time reducing the growing stock by 50%). For collecting information crop was to be measured at the ages of 7, 10, 15 and 20 years. Sets of 18 plots, were laid out in the annual coupe in 3 successive years, starting from 1941. Each set was divided into two blocks of 9 plots by arranging the plots in descending order on the basis of the average dominant height of the previous rotation crop and placing the first 9 plots in one set and the remaining 9 in the other. The nine treatments were allotted in a purely random fashion within each block. Thus a total of fifty four plots were laid out in the years 1941 to 1943, giving six replications of the 9 initial spacing-cum-thinning treatments.

Analysis

Data collected till the age of 7 years, by which time no thinning treatment had been given to the plot, was analysed (Mathauda, 1954) by the method of analysis of variance. It revealed that :

"Three initial spacings viz. 1.83, 2.74 and 3.66 m square have been under trial. Increase in planting espacement cuts down mortality rate and accelerates diameter growth. But while the difference between 1.83 m spacing on the one hand, and 2.74 and 3.66 m

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spacings on the other, is highly significant, that between the latter two alone is not significant at the 5% probability level. Basal area production shows an exactly opposite trend. The drop in this parameter from 1.83 m to 2.74 m spacing is not significant, while that from either of these two to the 3.66 m spacing has turned out to be highly significant. Statistical and graphical analyses of the data indicate the 2.74 m square espacement probably provides the crop optimum conditions of growth till the age of 7 years".

It was also mentioned that there had been unforeseen early mortality which was exceptionally high in 1943 plots, wiping out more than 50% of the stems in some cases, with the result that this set was not used in analysis at all.

Since then, in spite of the fact, that experiment was closed in the year 1960, data remained unanalysed. Frobably it remained so because :

(i) there was erratic time to time mortality in the plots and further,

(ii) measurements and thinning treatments were not carried out as scheduled.

Thinnings were carried out at 9th, 10th and 11th year of age instead of 10 years, 12th, 13th and 15th years of age instead of 15 years; and last measurement was taken at 17th, 18th and 19th year of age instead of 20 years. The method of analysis of variance if used would not have yielded reliable results. Therefore, analysis of data by multiple regression method (Bella and Franceschi, 1980) has been attempted. In addition to 'Spacing', a measure of 'growing space' to explain growth variation on account of mortality (including thinnings), has been introduced as independent variable in the regression. In the analysis none of the plot has been rejected as against 18 plots in earlier analysis.

Results

Growth of *Casuarina* is influenced by spacing as well as mortality in the initial years of growth and in subsequent years the increment put on depends on the built up cumulative volume in past years. Thinnings in subsequent years do not influence the growth (Table 1, level of significance .01). For the three different spacings, estimate of stand volume and increment for fully stocked ($x_3 = 1.0$) stands would be as follows :

Square spacing	(Volume/ha in m³)					
	At 7 years		At 12 years		At 18 years	
	Volume	M.A.I.	Volume	M.A.I.	Volume	M.A.I.
1.83 m (6′)	44.792	6.399	73.349	6.112	92.132	5.118
2.74 m (9′)	37.986	5.427	63.950	5.329	81.185	4.510
3.66 m (12′)	28.456	4.065	51.509	4.294	67.020	3.723

It indicates that in unthinned crop maximum M A.I. of 6.399 m^3 per hectare per annum is attained at 7 years in spacing of 1.83 m square in locality where crop attains top height of 19-21 m at the age of 18 years (Singh, 1978). Probably denser spacing than 1.83 m square may yield higher yields at even smaller period.

If we relax the level of significance to 0.1, then spacing and growing space ratio becomes also significant during middle and latter periods of growth in *Casuarina* stands—(Table 1). By use of these growth relations, estimate of stand volume and increments as per planned thinning would yield as under :

Square spacing (m)	Unthinned plots (volume/ha in m^3)					
	At 7 years		At 12 years		At 20 years	
	Volume	M.A.I.	Volume	M.A.I.	Volume	M.A.I.
1.83	40.987	5.855	70.939	5.912	97.860	4.893
2.74	42.404	6.058	69.756	5.813	96.424	4.821
3.66	26.193	3.742	45.841	3.820	68.306	3.415

Square spacing (m)	Plots thinned at 10 years (volume/ha in m^3)					
	At 7 years		At 10 years		At 20 years	
	Volume	M.A.I.	Volume	M.A.I.	Volume	M A.I.
1.83	40.987	5.855	58.958	5.895	88.967	4.448
2.74	42.404	6.058	58.815	5.882	88.792	4.440
3.66	26.193	3.742	37.981	3.798	64.127	3.206

Square spacing (m)	Plots thinned at 7 and 15 years (volume/ha in m^3)					
	At 7 years		At 15 years		At 20 years	
	Volume	M.A.I.	Volume	M.A.I.	Volume	M.A.I.
1.83	40.987	5 855	88.910	5.927	107.438	5.372
2.74	42.404	6.058	86.168	5.745	104.239	5.212
3.66	26.193	3 742	57.629	3.842	71·802	3.590

Table 1

Regressions of volume increment over spacing, growing space ratio and cumulative volume i.e. standing volume plus cumulative thinnings (before growing period)

Independent variables: x_1 = spacing (m); $x_2 = x_1^2$; x_3 = grwoing space ratio*; $x_4 = x_3^2$; x_5 = cumulative volume before growing period; $x_6 = x_5^2$

Dependent variable	Regression coefficients + a	b_1	b_2	b_3	b_4	b_5	b_6	Multiple regression coefficient R	Number of observations N
Volume increment upto 7 years of age	8.66954		−.23260	−1.49281				.504	54
	−.78426	7.10708[k]	−1.50609	−1.32070				.552	54
Volume increment during middle period	3.86547						.00092	.534	54
	5.83180	−.67576[k]					.00083	.575	54
Volume increment during last lap till harvest	2.05457						.00020	.360	54
	2.47740				−.06846[k]		.00019	.433	54

* Growing space ratio has been taken equal to 'growing space per tree (square spacing) divided by the $(\text{spacing})^2$. The ratio is equal one for a particular spacing with no mortality.

\+ All regression coefficients were significant at .01 level, except marked k.

k Regression coefficients were significant at 0.1 level.

The above values indicate that at 7 years maximum M.A.I. of 6 058 m^3 is attained in 2.74 m square spacing though in subsequent period 1,83 m × 1.83 m becomes better yielder. In thinned plots the 'rotation' for maximum volume production is pushed higher up and the yield does not appreciably falls espacially in plots thinned twice.

Conclusion

Casuarina in Puri areas attain maximum volume in about 7 years time in fully stocked stands yielding M.A.I. 6.058/6.399 m^3 per ha, per annum in spacing 2.74 m/1.83 m square. Stands in this region reach 19–21 m top height in 19 years. Where tree size is important, plantations grown at 1.83 × 1.83 m spacing could be thinned at 7 years and harvested at 15 years of age without much production loss. The study amply reveals that higher stocking forces early harvest.

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NUTRIENTS COMPOSITION OF SOME FODDER TREE LEAVES AVAILABLE IN SUB-MOUNTAINOUS REGION OF HIMACHAL PRADESH

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Introduction

Economic feeding of dairy animals requires the availability of palatable and nutritious fodders around the year. This is possible only by having a combination of cultivated fodders, good quality grasses and nutritious but palatable tree foliage. This has a major significance especially for the sub-mountainous regions, where the land available for crop production is already limited and further extension of fodder production area is unadvisable. However, vast areas of waste lands, which are unfit for crop production can be profitably covered under the suitable fodder trees. Therefore, it calls for a judicious selection of the suitable species of fodder trees for plantation on these waste lands or for raising forests particularly near the centres of livestock farming. Keeping this object in view, the present investigation was undertaken to have a comparative information regarding the nutrient components and some trace-minerals of commonly available eleven species of fodder trees from the bioclimatic zones of Kangra region i.e. high rainfall mountainous zone and hot & humid shivalik zone.

Material and Methods

Samples of ten species of fodder tree leaves, commonly fed during winter periods as green foliage, were collected from the high rainfall mountainous zone (Palampur), and six from the hot & humid shivalik zone (Jawalamukhi), during the months of October and November. The collected samples were sun-dried at site and later on oven-dried at 105°C for 8 hours, pulverized and ultimately ground to the fineness of 60 mesh screen for chemical analysis. All the samples were analysed for proximate principles, cell-wall and cell-constituents, macro-minerals i.e. Calcium (Ca), phosphorus (P) and trace-minerals i.e. copper (Cu) and zinc (Zn). The proximate principles and Ca were determined by the standard methads of A.O.A.C. (1975), cell-wall and cell-constituents by the methods of Goering and Van Soest (1970), phosphorus by the method of Parks and Dunn (1963), while the trace-minerals by atomic absorption spectroscopy.

Results and Discussion

Chemical composition. The results for the estimations of crude protein (CP), crude fibre (CF), ether-extract (EE), total ash, nitrogen-free-extract (NFE), calcium (Ca) and phosphorus

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(P) of different samples are shown in Table 1. Only five samples of fodder tree leaves viz. siras *(Albizzia lebbek)*, tuni *(Cedrela toona)*, biul *(Grewia oppositifolia)*, magar *(Bambusa arundinacea)* and toot *(Morus alba)* were available from both the locations. The results show that the CP and CF levels are comparatively higher and NFE levels lower in the samples collected from high rainfall zone (Palampur) than those from hot & humid shivalik zone (Jawalamukhi) and this variation may be due to the differences in their agro-climatic conditions. The overall proximate composition of the samples collected from the former area is, in general, in agreement with that reported by Sharma *et al.* (1966) excepting some variations in the crude protein content of siras *(Albizzia lebbek)* in which it is lower viz. 17.87 vs. 26.50 and khirk *(Celtis australis)* in which it is higher viz. 18.08 vs. 13.16. The average chemical composition of siras *(Albizzia lebbek)*, toot *(Morus alba)* and beri *(Zizyphus nummularia)*, collected from the hot & humid shivalik zone (Jawalamukhi) are almost matching with those reported by Sen *et al.* (1978).

The average percentage composition of the different species under high rainfall conditions (Palampur) varied in respect of crude protein from 10.35 in oee *(Albizzia stipulata)* to 26.40 in toot *(Morus alba)*, crude fibre from 11.63 in toot *(Morus alba)* to 33.10 in siras *(Albizzia lebbek)*, NFE from 36.14 in magar *(Bambusa arundinacea)* to 50.25 in kachnar *(Bauhinia variegata)*, total ash from 6.72 in kachnar *(Bauhinia variegata)* to 16.43 in khirk *(Celtis australis)*, calcium from 0.65 in magar *(Bambusa arundinacea)* to 3.16 in khirk *(Celtis australis)* and phosphorus from 0.11 in siras *(Albizzia lebbek)* to 0.35 in toot *(Morus alba)*. While such variations under the hot & humid shivalik zone (Jawalamukhi) are in respect of crude protein from 12.68 in tuni *(Cedrela toona)* to 18.24 in toot *(Morus alba)*, crude fibre from 10.28 in toot *(Morus alba)* to 27.29 in magar *(Bambusa arundinacea)*, NFE from 37.30 in magar *(Bambusa arundinacea)* to 55.63 in beri *(Zizyphus nummularia)*, total ash from 9.38 in siras *(Albizzia lebbek)* to 13.84 in magar *(Bambusa arundinacea)* and toot *(Morus alba)*, calcium from 0.43 in magar *(Bambusa arundinacea)* and 3.91 in toot *(Morus alba)*, while phosphorus from 0.13 in siras *(Albizzia lebbek)* to 0.48 in toot *(Morus alba)*.

The scoring of fodder trees, when done on the basis of crude protein, ether-extract (useful nutrient moieties) and, crude fibre levels (having depressing effect on the digestibilities of nutrients due to lignin contents) and their comparative palatabilities, toot *(Morus alba)* has the highest score while oee (*Albizzia stipulata*) has the lowest. Out of the list, the first three viz. toot (*Morus alba*), biul (*Grewia oppositifolia*) and Magar (*Bambusa arundinacea*) seem to be best for both the locations. Pal *et al.* (1979) also graded these fodder trees on the basis of the crude protein, crude fibre and tannins contents of their foliage and graded dheon (*Artocarpus lakoocha*) superior to magar (*Bambusa arundinacea*) but it is contrary to the observations that not only the later is nutritionally superior, but is ecologically better adaptable, quick growing and has more plantable foliage. With these merits, magar (*Bambusa arundinacea*) can be a more suitable species for plantation on the sides of rivulets and slopy areas with the benefits of providing effective soil conservation measures, abundant green foliage for cattle and bamboos serving as raw materials for supporting small scale industries for the local artisans.

Table 1

Chemical composition of different fodder tree leaves (on dry matter basis) and their observed palatabilities.

Sr. No.	Name of tree fodder	Locality	CP	CF	EE	Ash	NFE	Ca	P	Observed palatability
1.	Siras (*Albizzia lebbek*)	Palampur	17.87	33.10	3.88	8.83	36.62	2.65	0.11	Average
		Jawalamukhi	15.59	26.15	4.92	9.38	43.96	2.27	0.13	
2.	Tuni (*Cedrela toona*)	Palampur	14.83	12.03	12.50	11.99	48.65	2.50	0.13	Poor
		Jawalamukhi	12.68	14.03	7.42	11.86	54.01	2.12	0.33	
3.	Kachnar (*Bauhinia variegata*)	Palampur	15.25	24.36	3.42	6.72	50.25	2.13	0.27	Average
4.	Biul (*Grewia oppositifolia*)	Palampur	18.32	20.95	3 39	10.63	46.71	2.41	0.28	Good
		Jawalamukhi	17.30	17.97	4.04	11.95	48.74	3.00	0.19	
5.	Khirk (*Celtis australis*)	Palampur	18.08	18.10	2.19	16.43	45.20	3.16	0.26	Good
6.	Oee (*Albizzia stipulata*)	Palampur	10.35	32.75	3.86	7.71	45.33	1.12	0.23	Average
7.	Magar (*Bambusa arundinacea*)	Palampur	18.02	29.25	5.05	11 54	36.14	0.65	0.22	Good
		Jawalamukhi	16.76	27.29	4.81	13.84	37.30	0.43	0.26	
8.	Toot (*Morus alba*)	Palampur	26.40	11.63	5.06	16 28	40.63	2.38	0.35	Good
		Jawalamukhi	18 24	10.28	6.21	13.84	51.43	3.91	0.48	
9	Beri (*Zizyphus nummularia*)	Jawalamukhi	14.99	16.48	2.20	10.70	55.63	0.48	0.32	Good
10.	Dheon (*Artocarpus lakoocha*)	Palampur	14.45	21.10	2 40	12.13	49.92	1.11	0.31	Average
11.	Robinia (*Robinia pseudoacacia*)	Palampur	17.55	18.02	4.28	4.09	43.94	1.46	0.21	Good

Table 2

Cell-wall, cell constituents (% on d.m.b.), copper & zinc (mg/100 g) of different tree fodder leaves.

Sr. No.	Name of tree fodder	Locality	NDF	Cell contents (100–NDF)	ADF	Hemicellulose (NDF–ADF)	Cu	Zn
1.	Siras (*Albizzia lebbek*)	Palampur	52.68	47.32	33.80	18.88	0.54	1.04
		Jawalamukhi	54.50	46.50	46.28	18.22	0.69	1.44
2.	Tuni (*Cedrela toona*)	Palampur	37.46	62.54	20.03	17.43	0.81	*
		Jawalamukhi	47.59	52.41	29.11	18.48	1.22	4.51
3.	Kachnar (*Bauhinia variegata*)	Palampur	59.81	40.19	46.59	13.22	2.80	3.50
4.	Biul (*Grewia oppositifolia*)	Palampur	45.56	54.44	29.67	15.89	1.69	2.06
		Jawalamukhi	47.14	52.86	32.36	14.78	1.42	2.66
5.	Khirk (*Celtis australis*)	Palampur	37.21	62.79	27.12	10.09	1.68	2.63
6.	Oee (*Albizzia stipulata*)	Palampur	68.37	31.63	33.29	35.08	1.24	5.17
7.	Magar (*Bambusa arundinacea*)	Palampur	70.05	29.95	30.06	39.99	1.46	2.87
		Jawalamukhi	72.11	17.89	35.12	36.99	2.05	3.00
8.	Toot (*Morus alba*)	Palampur	41.20	58.80	23.77	17.43	2.08	4.83
		Jawalamukhi	43.16	59.84	26.68	16.48	1.41	5.08
9.	Beri (*Zizyphus nummularia*)	Jawalamukhi	70.90	29.10	59.63	11.27	1.32	3.50
10.	Dheon (*Artocarpus lakoocha*)	Palampur	54.48	45.52	38.72	15.76	0.96	4.48
11.	Robinia (*Robinia pseudoacacia*)	Palampur	51.68	48.32	34.20	17.48	1.90	*

* Sample spoiled.

Cell-wall and cell-contents. Van Soest's system of feed stuff analysis has been widely acclaimed superior to the Weende System, because the former gives better appraisal of the nutritive value of forages in relation to animal's performance (Van Soest and Robertson, 1979). With this idea, all the collected samples were also analysed for neutral detergent fibre (NDF), acid detergent fibre (ADF) and the values were also calculated for cell-contents (100-NDF) and hemicellulose (NDF-ADF) and the results are shown in Table 2. The perusal of the results show that the NDF and ADF contents of the five species, the samples of which were available from both the locations, are lower under high rainfall conditions (Palampur) than those from the hot and humid shivalik conditions (Jawalamukhi), with a reverse indication for the cell-contents, which suggests that the comparatively warmer environment has a tendency for the synthesis of more detergent fibres and incidently extensive lignification at the expense of the readily utilizable cell-contents, thereby comparatively reducing the nutritive value of the green foliage. There was no distinct variation in the hemicellulose levels in the samples from both the locations.

The average fibre percentage of the foliage samples under high rainfall conditions (Palampur) varied in respect of NDF from 37.21 (*Celtis australis*) to 70.05 (*Bambusa arundinacea*), ADF from 20.03 (*Cedrela toona*) to 59.63 (*Zizyphus nummularia*) while hemicellulose from 10.09 (*Celtis australis*) to 39.99 (*Bambusa arundinacea*). The cell-contents under these conditions ranged from 29.95 (*Bambusa arundinacea*) to 62.72 per cent (*Celtis australis*). Under hot and humid shivalik conditions (Jawalamkhi) the per cent variations in respect of NDF are 43.16 (*Morus alba*) to 72.11 (*Bambusa arundinacea*), ADF 26.68 (*Morus alba*) to 59.63 (*Zizyphus nummularia*), the hemicellulose 11 27 (*Zizyphus nummularia*) to 36.99 (*Bambusa arundinacea*), while the cell-contents 17.89 (*Bambusa arundinacea*) to 59 84 (*Morus alba*).

When the grading of the tree fodders is done on the basis of quantitative levels of cell contents (100-NDF) and hemicellulose (NDF-ADF), coupled with their palatabilities, their standing for high rainfall areas (Palampur) comes in the order of toot (*Morus alba*), khirk (*Celtis australis*). buil (*Grewia oppositifolia*), magar (*Bambusa arundinacea*), robinia (*Robinia pseudcacacia*), siras (*Albizzia lebbek*), oee (*Albizzia stipulata*), kachnar (*Bauhinia variegata*), dheon (*Artocarpus lakoocha*) and tuni (*Cedrela toona*), while for hot and humid shivalik areas (Jawalamukhi) this sequence stands in the order of toot (*Morus alba*), biul (*Grewia oppositifolia*) magar (*Bambusa arundinacea*), siras (*Albizzia lebbek*), beri (*Zizyphus nummularia*) and tuni (*Cedrela toona*). Tuni on the basis of its cell-wall analysis seems to provide the most nutritive foliage of all, but its palatability being poor due to the bitter and astringenet taste (may be due to high contents of saponin and tannins) is not relished by the cattle and is nibbled only when they are too hungry, but its wood is famous as quality timber.

Trace minerals. The data for trace-minerals contents of different fodder tree leaves (Table 2), reveals that under high rainfall conditions (Palampur), the Cu and Zn levels varied from 0.54 (*Albizzia lebbek*) to 2.80 mg/100 g (*Bauhinia variegata* and 1.04 (*Albizzia lebbek*) to 5.17 mg/100 g (*Albizzia stipulata*) respectively while for hot & humid shivalik zone

(Jawalamukhi) the respective variation are 0.69 (*Albizzia lebbek*) to 2.05 mg/100 g (*Bambusa arundinacea*) and 1.44 (*Albizzia lebbek*) to 5.08 mg/100 g (*Morus alba*). The literature values for biul (*Grewia oppositifolia*) and khirk (*Celtis australis*) are in agreement with the observed results (Sawhney *et al.*, 1973 a, b). According to the minimum recommended levels of 1.0 and 5.0 mg/100 g of Cu and Zn respectively in different feedstuffs by Underwood (1971), all the fodder trees except siras (*Albizzia lebbek*), tuni (*Cedrela toona*) and dheon (*Artocarpus lakoocha*) contained sufficient amount of Cu, while all the species except toot (*Morus alba*) are dificient in Zn.

In the light of above discussions it appears that toot (*Morus alba*) is the best fodder tree for both the locations on the basis of its chemical composition, cell-wall analysis and mineral contents. Besides the foliage serving as a composite whole some fodder for cattle, are also famous for silk worm rearing, its twigs and their barke are also highly prized. Biul (*Grewia oppositifolia*), magar (*Bambusa arundinacea*), khirk (*Celtis australis*) are the next best choices because their leaves are quite nutritious except they are deficient in zinc and are well adaptable from 500 m to 1500 m above mean sea level. In the third category we can group the rest of the fodder trees excepting siras (*Albizzia lebbek*), tuni (*Cedrela toona*), oee (*Albizzia stipulata*) and dheon (*Artocarpus lakoocha*) which are not only dificient in trace minerals (Cu & Zn), but some also contain toxic principles (*Albizzia lebbek*) and (*Albizzia stipulata*) or have poor palatability (*Cedrela toona*).

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SUMMARY

Ten species of fodder trees from the high rainfall mountainous zone (Palampur) and six species from the hot and humid shivalik zone (Jawalamukhi) were selected for determining the comparative nutritive value, cell-wall and cell-contents, macro-minerals (Ca & P) and trace-minerals (Cu and Zn). The comparison was possible only in five species viz siras (*Albizzia lebbek*), tuni *Cedrela toona*), biul (*Grewia oppositifolia*), magar (*Bambusa arundinacea*) and toot (*Morus alba*). The crude protein (CP) and crude fibre (CF) levels are higher and nitrogen -free-extract (NFE) lower in the samples from high rainfall mountainous zone as compared to those of hot and humid shivalik zone. Similarly the neutral-detergent fibre (NDF) and acid-detergent fibre (ADF) levels are lower and reverse is the case for cell-contents in the samples from the first zone as compared to those of second zone. Excepting siras (*Albizzia lebbek*), tuni (*Cedrela toona*) and dheon (*Artocrpus lakoocha*), all the fodder tree leaves were sufficiently rich in copper viz. more than 1 mg/100 g, while all were deficient in zinc viz. less than 5 mg/100 g except toot (*Morus alba*). On the basis of overall chemical analysis, toot (*Morus alba*) stands first, successively followed by biul (*Grewia oppositifolia*) magar (*Bambusa arundinacea*) aud khirk (*Celtis australis*), all of them were well adaptable for both the zones. Tuni (*Cadrela toona*) foliage however, has a very good nutritive value excepting deficient in trace-minerals, but its palatability is very poor. Similarly siras (*Albizzia lebek*)and oee

(*Albizzia stipulata*) are not only nutritionally poorer but also prove some times toxic (fresh growth).

हिमाचल प्रदेश के उप-पर्वतीय प्रदेश में उपलब्ध कतिपय चारा वृक्षों की पत्तियों का पोष्याहार गठन

लेखक विनोद खत्ता व बी०एस० कटोच

सारांश

तुलनात्मक पोषण अर्हा, कोशाभित्ति और कोशा अन्तर्वस्तु, बड़े खनिज (कैलसियम व फास्फोरस) और अल्प खनिज (तांबा व जस्ता) विनिश्चित करने के लिए अधिक वर्षा वाले पर्वतीय क्षेत्र (पालमपुर) से दस चारा वृक्ष जातियां तथा गर्म और आर्द्र शिवालिक प्रदेश (ज्वालामुखी) से छह चारा वृक्ष जातियां चुनी गई। तुलना केबल पांच जातियों अर्थात् शिरीष (एब्बीज्जिया लेब्बेक), तुनी (सिडरेला तुना), बिऊल (ग्रीविया अपोजिटी-फोलिया), मगर (बम्बूसा अरुनडिनेसिया) और तूत (मोरस एल्बा) में की जा सकी। गर्म और आर्द्र शिवालिक क्षेत्र की वृक्ष जातियों की तुलना में अधिक वर्षा वाले पर्वतीय क्षेत्र की वृक्ष जातियों के नमूनों में कच्चा प्रोभूजिन (प्रोटीन) और कच्चा रेशा स्तर ऊंचे तथा नाईट्रोजन मुक्त निस्सार स्तर नीचा है। इसी प्रकार क्लीव प्रक्षालक रेशा और अम्ल प्रक्षालक रेशा स्तर नीचे है तथा कोशा अन्तर्वस्तु विचार से दूसरे क्षेत्र की तुलना में पहले क्षेत्र के नमूनों में स्थिति इससे उल्टी है। शिरीष (एल्बीज्जिया लेब्बेक), तुनी (सिडरेला तुना) और ढेऊं (आर्टोकार्पस लकुचा) को छोड़ कर सभी चारा वृक्षों की पत्तियां तांबे में पर्याप्त सम्पन्न अर्थात् मि०/100 ग्राम से अधिक है जबकि तूत (मोरस एल्बा) को छोड़ कर सभी जस्ते में विपन्न अर्थात् 5 मिग्रा०/100 ग्राम से कम हैं। समग्र रासायनिक विश्लेषण के आधार पर तूत (मोरस एल्बा) पहले नम्बर पर आती है जिसके पश्चात् क्रमानुसार बिऊल (ग्रीविया अपोजिटीफोलिया), मगर (बम्बूसा अरुनडिनेसिया) और खिर्क (कैल्टिस आस्ट्रेलिस) आते हैं जिनमें सभी दोनों प्रदेशों के लिए अनुकूल बन सकने वाली हैं। अल्प खनिजों में विपन्न होने की बात छोड़ कर तुनी (सिडरेला तुना) की पत्तियां बहुत अच्छी पोषण अर्हा वाली हैं परन्तु इसका स्वाद बहुत घटिया है। इसी प्रकार शिरीष (एल्बीज्जिया लेब्बेक) और ओई (एल्बीज्जिया स्टिपुलेटा) न केवल पोषण अर्हा में घटिया हैं बल्कि उनमें कभी-कभी विषैलापन (नई वृद्धि में) भी पाया जाता है।

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PERFORMANCE OF *DIOSCOREA FLORIBUNDA* MART AND GAL AT SEPAHIJALA, TRIPURA

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Introduction

Dioscorea floribunda Mart & Gal is one of the species of Central American origin, which has been introduced and acclamatised in certain areas of the plains of India, as a good source of diosgenin, a starting material for the production of cortico-steroid, sex hormones and oral contraceptives.

According to the target proposed in the Hathi Committee Report the annual production of diosgenin in the country should reach 120 tonnes by 1983-84. Accordingly, by that time the acreage under *Dioscoreas* may have to be raised to about 6,000, i.e., about six times the present acreage. Since *Dioscorea floribunda* and another species, *D. composita*, also of Central American origin, can be grown successfully in the plains of India, a rapid increase in their acreages may be feasible, provided suitable areas have been determined for their optimum growth and yield.

Performance of *Dioscorea floribunda* and *Dioscorea composita* under the conditions of Jorhat, Assam has been reported (Singh *et al.*, 1978). While the biomass in the case of *Dioscorea composita* was found to be appreciably higher, the diosgenin content was higher in the case of *Dioscorea floribunda.*

The Regional Research Laboratory, Jorhat had undertaken trials on *Dioscorea floribunda* at one of its sub-stations at Sepahijala, Tripura, since 1976. Sepahijala sub-station is located about 30 km South of Agartala, at 22°56′ & 24°34′ N latitude, and 91°10′ & 9_°22′ E longitude, and at an altitude of about 32 m above sea level. The soil is sandy to sandy loam with an average pH around 5.8. The temparature ranges from 9.7°C (min) and 25.5°C (max) in January to 25.7°C (min) and 33.4°C (max) in April–June. The rainfall ranges from 0.9 mm in January to 565 mm in the month of July. The months of heavy rainfall being June to September, slight are recorded during the season December to May.

Some of the trials conducted at Sepahijala, Tripura, with *Dioscorea floribunda* and the results obtained are presented in this communication.

Material and Methods

Tubers raised at RRL, Jorhat from seeds obtained from the U.S. Deptt. of Agriculture were used for study at Sepahijala. Propagation at Sepahijala was mainly vegetative through

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tubers and propagation by air and ground-layering were also applied. Besides studies on vegetative multiplication, agronomic trials and selection of high yielding clones were undertaken. Trials were conducted mainly under rainfed conditions, although occasional irrigation was provided during the lean months of December to May in the total absence of rain.

Experimental and Results

Rooting by air-layering and ground layering. 50 (fifty) nodes with leaves from the middle of the twigs were selected for the study. Nodes were scratched by a blade and treated with different concentration of hormone solution. The different concentration of hormones used were NAA (100, 500, 1000 & 5000 ppm) and IBA (100, 500, 1000 & 5000 ppm). Control was treated with distilled water. For air-layering, the treated nodes were tied with compost by polythene strips and for ground-layering the nodes were placed under the soil having good amount of organic manure keeping the leaves above ground. Watering was done regularly to keep the nodes moist. Observation was recorded on 45th day from the date of layering.

Table 1

Rooting by air-layering

Treatment		No. of nodes layered	Rooting	
			No.	%
NAA	100 ppm	50	18	36
	500 ppm	50	20	40
	1000 ppm	50	24	48
	5000 ppm	50	17	34
IBA	100 ppm	50	5	10
	500 ppm	50	6	12
	1000 ppm	50	10	20
	5000 ppm	50	28	56
Control	Dist. Water	50	7	14

A perusal of Table 1 & 2 indicates that under the condition prevailed during July-August, ground-layering with 5000 ppm IBA was more effective than that of NAA. The percentage of rooting by this treatment (IBA 5000 ppm) was 82%. Similar observation was observed by Bammi *et al.*, (1972) in case of single node cutting. Generally NAA is better than IBA. However, 5000 ppm IBA gave the best performance. The high percentage of rooting in July-August (rainy season) may be due to high humidity in the atmosphere.

Table 2

Rooting by ground-layering

Treatment		No. of nodes layered	Rooting	
			No.	%
NAA	100 ppm	60	21	42
	500 ppm	50	25	50
	1000 ppm	50	36	72
	5000 ppm	50	20	40
IBA	100 ppm	50	9	18
	500 ppm	50	12	24
	1000 ppm	50	17	34
	5000 ppm	50	41	82
Control	Dist. Water	50	9	18

It was generally observed that ground-layering gave better result than air-layering.

Sprouting of tuber in different months of the year. As *Dioscorea floribunda* remains dormant for sometime (Bammi *et al* , 1972) after harvest an experiment was conducted to find out the sprouting behaviour of different portions of tuber. The portion used were *crown* and *mid and tip* (Mixed) weighing about 50-60 gms each. The Benlate (5000 ppm) treated tuber portion (crown and mid + tip each 30 nos) were preserved under sand : soil (60 : 40) beds in the nursery shade. The beds were kept moist through out the period of sprouting i.e., upto 150 days in case of tubers preserved during October & November. Tuber preservation was done 10th day of every month commencing from January. Observations were taken at 10 and 15 days interval in case of crown and mid + tip portions, respectively.

Table 3 reveals that the crown portion sprouts first followed by mid + tip. 100% sprouting was observed with in 10–20 days in case crown when preserved in March to September. This became minimum in the month of December may be due to low temperature. In case of mid + tip 90% sprouting were observed with in 30-45 days when preserved in March while remaining 10% was sprouted with in another 10 days time. Some rooting occurred in the tubers preserved in February.

Effect of time of planting on yield of Dioscorea floribunda. This experiment involves 12 monthly planting on 10th of every month and harvesting exactly 12 months after planting. Materials used were a mixture of mid and tip portions each weighing approximately 50-60 gms. The experiment was laid out in a Randomise block designed plot with 3 replications. Number of plants per plot was 20 sown in a spacing of 45×45 cm. P_2O_5 and K_2O @ 150 kg/ha alongwith compost @ 20 t/ha were added as basal during soil preparation. The sources of P & K

Table 3

Percentage of sprouting

Month of sowing	Crown		Mid + Tip							
	10–20	21–30	30–45	46–60	61–75	76–90	91–105	106–120	121–135	136–180
	(time taken in days)									
January	40	60	—	30	16.6	36.6	16.6	—	—	—
February	25	75	73.3	20	—	6.6	rest	rotted	—	—
March	100	—	90	10	—	—	—	—	—	—
April	100	—	20	70	6.6	3.3	—	—	—	—
May	100	—	56.6	26.6	16.4	—	—	—	—	—
June	100	—	13.3	46.6	10.0	20.0	10.0	—	—	—
July	100	—	10.0	40.0	3.0	26 6	10.0	10.0	—	—
August	100	—	—	90	3.3	4.3	2.4	—	—	—
September	100	--	3.3	80	3.4	6.4	3 2	3 3	—	—
October	60	40	—	13.3	6.6	—	6 6	26.6	23.3	—
November	—	42	—	—	—	—	—	60	33.3	—
December	—	10	—	—	—	33.4	50.2	16.4	—	—

Table 4

Yield of tuber per plot (average of 3 replications)

Date of Planting	10th July	10th Aug.	10th Sept.	10th Oct.	10th Nov.	10th Dec.	10th Jan.	10th Feb.	10th Mar.	10th Apr.	10th May	10th June	SE	CD 5%
	2.98	1.88	2.46	2.42	5.96	6.40	8.14	9.96	14.04	14.92	13.42	9 12	0.24	0.84

Table 5

Yield of tuber in kg/plot (average of 4 replications)

Treatments	C_X	C_Y	C_Z	M_X	M_Y	M_Z	T_X	T_Y	T_Z	SE	CD 5%
Yield	11.64	12.76	14.16	11.26	13.06	14.62	10.64	12.34	13.70	0.24	0.84

were single Super Phosphate and M/of Potash respectively. Nitrogen (in the form of Urea) @ 200 kg/ha was applied in four split doses. Occasional irrigation was provided as and when necessary during the lean months.

It may be seen from the data given in Table 4 that March, April and May planting were significantly supperior to planting in all other months. Among March, April and May the differences were not statistically significant, although April planting recorded highest yield.

It may be mentioned that in April planting, the average weight of one year old tuber was 0.746 kg/plant.

Effect of Planting of different sizes and portions of tuber of Dioscorea floribunda on yield. This experiment consists of 9 treatment (3 × 3) combinations i.e., Portion of Tuber (3) and weight of different portion (3). The portions used were crown (C), mid (M) and tip (T). The weight of tubers were 40–50 gms (X), 51–70 gms (Y) and 71–90 gms (Z). The experiment was laid on a Randomise block designed plots with 4 replications. The date of planting for crown was 23rd March, 1979 and for mid and tip it was 16th April, 1979. The crop was harvested on 15th May, 1980. The number of plants per plot were 20 with a spacing of 45 × 45 cm. Fertilizer application was same as in the case of the earlier experiment. Compost was added @ 20 t/ha. The crop was grown under rainfed condition although occasional irrigation was provided during the lean month i.e., November to February.

In this experiment, difference in yield of tuber among crown, mid and tip were not found to be significant. However, the size of tubers appears to have an effect on yield. Larger size of tubers (71–90 gm) is associated with significantly higher yield of tubers in case of all the treatments.

Further, it also appears that considering the size of tubers the yield was not upto the expection and it may be due to the prevailing drought condition in Tripura during the 1st quarter of the trial.

Selection of high yielding clones. In *Dioscorea floribunda*, the vine growth, color of tuber and diosgenin content from clone are variable. It was found that the tuber colors were ranging from deep yellow to white with slight tinge of yellow. Similar fi ding has also been reported by Bammi *et al*, (1972). There is also some co-relation in color of tuber and diosgenin content. Lighter the color of tuber higher the diosgenin content. So based on the above criteria, a few clones were selected which are reproduced in Table 6.

From the clones given in Table 6 only five clones were selected in the next year and these were 58, 59, 61, 62 & 64. Diosgenin analysis was done for all the clones except 62 for which the sample was infected by fungi (Table 7). In the Table 8 it is grouped together the value of the samples having the same age group and averaged their data to obtain their perspective. As it is seen, assuming the existance of no other variable the 10 months samples seem to be most promising.

Table 6

Clone selection of Dioscorea floribunda

Clone No.	Age Months	Yield of tuber (kg)	* Color of flesh	Weight of dry samples (gms)	Moisture (%)	Diosgenin (%)	Purity (%)	As 100 % Diosgenin	Year
45	33	3.660	Y	—	9.6	2.37	75.0	1.78	1980
46	33	3.830	Y	—	9.8	3.46	71.6	2.48	1980
47	33	3.460	Y	192.10	9.7	1.80	67.0	1.21	1980
48	33	3.400	Y	165.21	9.84	2.69	73.1	1.97	1980
49	18	1.570	Y	—	10.3	2.75	66.1	1.82	1980
50	18	2.130	PY	182.88	10.7	3.12	73.8	2.30	1980
51	18	—	Y	191.75	10.43	2.72	75.8	2.06	1980
52	17	1.920	Y	174.0	6.6	3.84	68.4	2.63	1980
53	17	1.674	PY	150.1	6.0	3.06	69.7	2.13	1980
54	17	2.100	Y	170.08	8.3	3.64	78.5	2.86	1980
55	17	1.835	Y	166.23	7.1	3.14	74.9	2.35	1980
56	17	1.900	PY	172.45	6.44	3.87	75.1	2.91	1980
57	10	0.850	W_1	162.85	6.9	3.53	75.1	2.65	1980
58	10	0.910	W_2	170.57	6.0	4.12	72.3	2.98	1980
59	10	0.750	W_2	172.08	5.4	4.21	71.7	3.02	1980
60	10	0.900	PY	172.84	6.9	2.52	78.1	1.97	1980
61	10	0.790	W_2	119.45	7.5	3.76	75.3	2.83	1980
62	10	0.540	W_2	181.07	5.8	3.06	76.9	2.35	1980
63	10	0.690	W_1	180.65	5.9	2.84	77.2	2.19	1980
64	10	0.845	W_2	178.64	5.6	4.24	67.0	2.84	1980

* Y – Yellow, PY–Pale Yellow, W_1 – White with Yellow shade in the border &
W_2 – White with slight yellow sting in the flesh.

Table 7

Clone selection of Dioscorea floribunda

Clone No.	Age Months	Yield of tuber (kg)	* Color of flesh	Weight of dry samples (gms)	Moisture (%)	Diosgenin (%)	Purity (%)	As 100 % Diosgenin	Year
58	10	0.876	W_2	175.80	16.0	3.65	76.5	2.79	1981
59	10	0.700	W_2	166.65	12.0	3.28	81.3	2.67	1981
62	10	0.630	W_2	182 75	12 0	3.05	77.1	2.35	1981
64	10	0.795	W_2	169.20	10.0	3.89	73.7	2.87	1981

Table 8

Summary of the clone selection of Dioscorea floribunda

Sl. No.	Number of samples	Age in months	Year	Average wt. (gms)	Average moisture (%)	Average Diosgenin (%)	Average purity (%)	Average Diosgenin 100% basis
1.	4	33	1980	178.66	9.735	2 58	71.68	1 86
	Maximum			192.10	9.84	3.46	75.0	2.48
	Minimum			165.21	9.60	1.80	67.0	1.21
2.	3	18	1980	187 32	10.48	2.86	71.9	2.06
	Maximum			191.75	10.7	3.12	75.8	2.30
	Minimum			182.88	10.3	2.72	66.1	1.82
3.	5	17	1980	166.57	6.89	3.51	73.32	2.58
	Maximum			174.0	8.3	3.87	78.5	2.91
	Minimum			150.1	6.0	3.06	68.4	2.13
4.	8	10	1980	167.27	6.25	3.54	74.19	2.60
	Maximum			181.07	7.50	4.24	78.10	3.02
	Minimum			119.45	5.40	2.52	67.00	1.97
5.	4	10	1981	173.60	12 5	3.46	77.15	2.67
	Maximum			182 75	16.0	3.89	81.3	2.87
	Minimum			166.65	1.00	3.05	73.7	2.35

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PROVENANCE-RELATED GROWTH RESPONSE OF *POPULUS CILIATA* WALL. EX ROYLE TO NITROGEN FERTILIZATION

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Introduction

Populus ciliata Wall. ex Royle, a native of the Western Himalaya (1300–3000 m), is a fast growing poplar possessing a great potentiality to replace valuable coniferous wood currently being used for packing cases in the temperate fruit zone. Its value as a nurse crop for silver-fir and raw material for match-sticks and pulp and paper has already been established. Owing to its natural wide range of distribution interrupted by mountainous ranges, *P. ciliata* exhibits large amount of geographic variation in growth characters.

Fast growing species require large amounts of nutrients for their optimum growth. For poplar growing it is of paramount importance that adequate nutrition is provided at nursery stage to get healthy and vigorous stock for plantations. Poplars require nitrogen in large quantities as compared to phosphorus and potassium and the plants remain stunted in growth in nitrogen deficient soils.

Different species of *Populus* have revealed varying responses to nitrogen application. However, information on fertilization of *P. ciliata* is scanty. Investigations on nutritional requirements of different clones of the species is a pre-requisite for identifying the clones suited to different site conditions. Therefore, the present study was designed to know the provenance-related response of *P. ciliata* to nitrogen fertilization.

Material and Methods

Hardwood cuttings of ten randomly selected trees of *Populus ciliata* were collected from two provenances–Kangni (2400 m) and Karain Bihal (1800 m) of Kulu Forest Division, by the end of February, 1981. The clonal material was raised at Shilli nursery (1300 m) of Department of Forestry, Himachal Pradesh Krishi Vishva Vidyalaya, Solan.

Soil of the experiment area was medium in N, P and K supplies with a sandy loam texture (Table 8).

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The treatments comprising two provenances (Kangni, Karain Bihal) and four levels of nitrogen (0, 30, 60, 90 kg/ha) were laid in a Randomized Block Design with three replications. Hardwood cuttings were planted at a spacing of 40 × 30 cm in well prepared beds (1 6 × 1.5 m) on 10th March, 1981.

Nitrogen was applied in the form of calcium ammonium nitrate. The required quantity of the fertilizer was applied in two equal splits; first after three months of planting and the second two months thereafter. Weeding and watering were done as and when required.

The field observations were recorded in the last week of September, 1981. Data on ten randomly selected plants per bed were recorded for plant height, collar diameter, internodal length and total biomass. Composite leaf samples were analysed for nitrogen (Jackson, 1967). Wood samples from the selected plants were taken for determining specific gravity (Smith, 1954) and fibre length (Pandeya *et al.*, 1968).

The data collected for different characters were statistically analysed by Methods of Analysis of variance as described by Panse and Sukhatme (1967).

Results and Discussion

Both the provenances exhibited enhanced growth with nitrogen fertilization. Plant height, collar diameter, internodal length and total biomass significantly increased upto the application of 60 kg N/ha (Table 1 to 4). Application of 90 kg N/ha, on an average adversely affected these characters, though not significantly. An increase in height and diameter of three hybrid poplars was observed by Sheedy (1976) with NPK treatment at a rate of 56 kg/ha, under nursery conditions. Dimitrov *et al.* (1976) also reported that application of N, P, K at a rate of 80 : 200 : 80 g/kg soil, respectively increased biomass of *Populus* × *euramericana* cv 'I-214' by 135 per cent over control Brar and Katoch (1980) noticed similar response of *P. deltoides* to nitrogen fertilization at an optimum dose of 50 kg N/ha. All these reports are in line with the findings of the present investigation.

Fibre length of the plants was increased to maximum with the application of optimum dose of nitrogen (60 kg N/ha) and higher dose of nitrogen decreased it (Table 7). Similar response was observed by Foulger *et al.* (1971) in a study on the effect of nutrient concentration on stem anatomy of eastern cottonwood seedlings. They reported that fibre length increased to maximum with the optimum levels of N and K and thereafter, it decreased as both N and K increased.

Nitrogen fertilization significantly increased foliar nitrogen over control, with an insignificant variation at different levels of application (Table 5). Thus, the positve growth

response to nitrogen application was as a result of improved nutrition of the plants. Coyne and Cleve (1977) observed increased foliar nutrients per unit leaf area with fertilization of quaking aspen stand. Blackmon (1977) also noticed an increase in foliar nitrogen along with more than double volume increment of *P. deltoides* during the year of fertilization.

Specific gravity of wood started decreasing with the application of higher doses after 30 kg N/ha (Table 6). This observation is supported by Debell *et al.* (1975), who, studied effect of application of ammonium nitrate (150 and 300 lbs/acre) on a plantation of *P. deltoides* and noticed that diameter and volume were markedly increased but specific gravity decreased by 3 per cent.

Plant height, collar diameter, total biomass, foliar nitrogen and fibre length were significantly higher in Karain Bihal as compared to Kangni provenance. Growth differences may be attributed to the altitudinal and edaphic factors of the provenances exerting selective pressure on tree populations. Karain Bihal is confined to an altitude of 1800 m on a riverain area, whereas, Kangni ascends to 2400 m on a landslide zone. It is likely that ortets have been adapted to the growing conditions of the sites. Ying (1975) reported that pattern of geographic variation resulted from adaptation to the gradients in the environment. Avanzo (1972) also observed the basal area of *P. deltoides* clones to be negatively correlated with the latitude of the provenance at the end of second year. The results are supported by Khosla and Khurana (1979) who found *P. ciliata* clones from ravine areas to perform better than those selected in forests on landslides.

Nitrogen × Provenance interactions were observed to be non-significant. However, Karain Bihal provenance attained maximum plant height and collar diameter at a lower nitrogen level than Kangni provenance (Table 1 and 2). Similar response in foliar nitrogen content (Table 5) revealed Karain Bihal provenance to be more efficient in nitrogen uptake. The narrow fertility range in the present experiment might be the reason for non-significant interactions. Curlin (1967) observed cottonwood clones to interact with levels of N in a nursery trial. Baker and Randall (1974) found strong clone × soil interaction on two contrasting sites.

The enhanced growth of *P. ciliata* with fertilization in the nursery suggests the application of CAN at a rate of 60 kg N/ha (two splits) for rapid multiplication of clonal material and production of vigorous nursery stock for planting in the field. The better performance of Karain Bihal, a provenance on riverain alluvium site with warm climate, supports the selection of clones on fertile habitats for future afforestation of *P. ciliata*.

Table 1

Effect of nitrogen doses on average plant height (m) in two provenances

Provenance	Nitrogen				Average	
	N_0	N_1	N_2	N_3		
Kangni	1.120	1.533	1.790	1.808	1.562	C.D. (P) .05
Karain Bihal	1.407	1.702	1.977	1.840	1.731	=0.089
Average	1.263	1.617	1.883	1.824		

C.D. (N) =0.127
.05

Table 2

Effect of nitrogen doses on average collar diameter (cm) in two provenances

Kangni	0.972	1.138	1.337	1.348	1.198	C.D. (P) .05
Karain Bihal	1.062	1.252	1.543	1.462	1.329	=0.067
Average	1.016	1.195	1.440	1.405		

C D. (N) =0.095
.05

Table 3

Effect of nitronen doses on average internodal length (cm) in two provenances

Kangni	3.483	4.138	4.667	4.508	4.199	C.D. (P) .05
Karain Bihal	3.752	4.315	4.853	4.545	4.366	=NS
Average	3.617	4.226	4.760	4.526		

C.D. (N) =0.265
.05

Table 4

Effect of nitrogen doses on average biomass (kg) in two provenances

Kangni	0.177	0 230	0.380	0.377	0.290	C.D. (P) .05
Karain Bihal	0.192	0.291	0.413	0.399	0.323	=0.032
Average	0.184	0.260	0.396	0.388		

C.D. (N) .05 =0.046

Table 5

Effect of nitrogen doses on average foliar nitrogen content (%) in two provenances

Kangni	3.018	3.303	3.470	3.507	3.324	C.D. (P) .05
Karain Bihal	3.325	3 505	3.573	3.537	3.485	=0.105
Average	3.171	3.404	3.521	3.521		

C.D. (N) .05 =0.149

Table 6

Effect of nitrogen doses on average specific gravity of wood in two provenances

Kangni	0.398	0.430	0.415	0.397	0.410	C.D. (P) .05
Karain Bihal	0.400	0.432	0.405	0.390	0.406	=NS
Average	0.399	0.430	0.410	0.393		

C.D. (N) .05 =0.011

Table 7

Effect of nitrogen doses on fibre length (mm) in two provenances

Provenance	Nitrogen				Average	
	N_0	N_1	N_2	N_3		
Kangni	0.380	0.418	0.437	0.427	0.415	C.D. (P) .05 =0.008
Karain Bihal	0.397	0.428	0.452	0.423	0.427	
Average	0.388	0.423	0 444	0.429		

C.D. (N) .05 =0.012

Table 8

Physio-chemical characteristics of the experimental area

Texture	E.C.	O.C. (%)	pH	Available nutrients (kg/ha)		
				N	P	K
Sandy loam	.02	.70	7.5	524	20	340

SUMMARY

Clonal material of *Populus ciliata* Wall. ex Royle, collected from two provenances—Karain Bihal (1800 m, 32.14°N, 77.11°E) and Kangni (2400 m, 32.19°N, 77.10°E) in the Kulu Forest Division, was tested for responsiveness to nitrogen fertilization in a nursery trial. Soil of the experimental area was medium in N, P and K supplies with a sandy loam texture. Calcium ammonium nitrate was used as a source for four levels (0, 30, 60, 90 kg/ha) of nitrogen.

Both the provenances exhibited enhanced growth with the application of nitrogen. Plant height, collar diameter, internodal lenght, total biomass, foliar nitrogen and fibre length significantly increased upto the application of 60 N/ha. The specific gravity was maximum with 30 kg N/ha and decreased with higher levels. On an average application of 90 kg N/ha resulted in an insignificant decrease in all the growth characters.

Karain Bihal provenance, representing the lower range of distribution of the species with better growth performance, tended to be more responsive to nitrogen fertilization in all growth characters studied except specific gravity, as compared to Kangni provenance, inhibiting higher zone with coniferous association.

पापुलस सिलियाटा वाली० पूर्व रायले का नाइट्रोजन उर्वरकों के प्रति उत्पत्ति स्थान सम्बन्धित प्रतिचार

लेखक जी०एस० दिओल व पी०के० खोसला

सारांश

कुलू वन मण्डल में दो स्थानों—करैन बिहाल (1800 मी०, 32.14° उ, 77.11° पूर्व) व कंगनी (2400 मी०, 82.19° उ, 77.10° पूर्व) से एकत्रित कृन्तकों को एक रोपणी परीक्षण में नाइट्रोजन उर्वरक देने के प्रति व्यवहार (प्रतिचारिता) के लिए परीक्षित किया गया। सम्परीक्षण क्षेत्र की मृदा नाइट्रोजन, फास्फोरस और पोटाशियम तत्वों के विचार से मध्यम थी जिसका वयन रेतीला दुमटी था। नाइट्रोजन के चार स्तरों (0, 30, 60, 90 किग्रा०/हिक्टेयर) के रूप में कैलशियम अमोनियम नाइट्रेट उपयोग किया गया।

दोनों उत्पत्ति स्थानों ने नाइट्रोजन दिया जाने पर अधिक बढ़वार प्रर्दाशित की। पादप ऊंचाई, मूल संधि पर व्यास, पर्व लम्बाई, कुल जैवपुंज, पत्तियों की नाइट्रोजन व रेशा लम्बाई में 60 किग्रा० नाइट्रोजन/हेक्टेयर देने पर सार्थक वृद्धि हुई। 30 किग्रा० नाइट्रोजन/हैक्टेयर देने पर आपेक्षिक गुरूत्व अधिकतम हुआ तथा अधिक मात्राएं दिए जाने पर धटने लगा। औसतन 90 किग्रा० नाइट्रोजन/हेक्टेयर देने पर वृद्धि लक्षणों में वृद्धि कुछ विशेष नहीं हुई।

करैन बिहाल स्थान की, जो इस जाति के विस्तार की निचली सीमा का प्रतिनिधि है जिसमें इसकी श्रेष्ठतर वृद्धि सक्रियता होती हैं कंगनी स्थल की तुलना में जो शंकुधर जातियों से मिला-जुला अधिक ऊंचा क्षेत्र है आपेक्षिक गुरूत्व को छोड़ कर अन्य सभी वृद्धि लक्षणों में नाइट्रोजन उर्वक दिए जाने पर अधिक प्रतिचारी प्रतीत होता पाया गया।

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CHEMICAL INVESTIGATION OF FATTY OIL OF *BURSERA PENICILLATA* SEED*

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Bursera penicillata (syn. *B. delpechiana*) commonly known as Indian Linaloe or Indian Lavender is a native of Mexico and was first introduced into India (Banglore) around the beginning of this century. In view of the increasing demand for its essential oil after its successful introduction, efforts were made to propagate the plant on a large scale and the Forest Research Laboratory too successfully raised some plants from stem cuttings during the fifties. The Karnataka Forest Department has started large scale plantations around Bangalore from 1958, and at present 836.21 hectares of *Bursera penicillata* plantations are existing around Bangalore (Kushalappa, 1978). Neighbouring States like Andhra Pradesh and Tamil Nadu have also raised this species in suitable areas.

The plant is noted for its pleasant smelling essential oil, which in general is found in almost all parts of the plant, but is concentrated mostly in the fruit husk (10–14% yield). The current market price of the oil is about Rs. 250/–per kg and it is largely used in perfumery, cosmetic and soap industries.

Bursera penicillata is a deciduous and mostly dioecious tree, propagated vegetatively by cuttings. The tree yields one crop of fruit every year during August–September. The yeild of husk from the existing plantations of Karnataka Forest Department alone is reported to be about 10 tonnes per year As most of the plants are still young it is bound to increase in the years to come, especially with more area coming under *Bursera* every year–at the rate of about 40 hectares per annum (Kushalappa, 1975). Besides this, there is a well established private plantation of *Bursera* in about 100 hectares near Bangalore. The seed, which accounts to nearly half the amount of the dry husk by weight, is not put to any use at present. Therefore, an attempt was made to find a suitable use for it.

The seed is small, irregular in shape, with a light brown outer coat with kernel inside, containing a fatty oil. The seed is light in weight (100 seeds weigh 2–2.5 g) and it is difficult to separate the kernel (37–38% by wt. of the whole seed) from it. Therefore, the entire seed was used for extraction of the oil. The crushed seed was extracted with petroleum ether (60–80°) in a Soxhlet. After removal of the solvent, a fatty oil was obtained in 17–18% yield (on the wt. of the whole seed). The physico-chemical characteristics of the oil were determined according to standard methods (A O.A.C., 1965) and the results are given in the Table. The acid value of the oil extracted from fresh and air-dried seed was low, where as it was invariably high (40–50) in the case of oil obtained from seeds stored for one of two years. This may be due to either incomplete drying or conditions and duration of storage of the seed after harvest.

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Table

Physico-chemical characteristics of the seed oil

Colour	Brownish yellow
Odour	agreeable
Refractive index (at 25°C)	1.4675
Specific gravity (at 25°C)	0.9054
Iodine value (Hanus)	110.7
Saponification value	117.7
Acid value	2.17
Unsaponifiable matter	2.73%

Composition of the seed kernel oil

The oil was saponified with alcoholic Potassium hydroxide and the liberated fatty acids, after removing the unsaponifiable matter, were separated into solid and liquid fatty acids by the Twitchell's Lead Salt method (A.O.A.C., 1965). The saturated and unsaturated acids were found to be in the ratio 1 : 3. The mixed methyl esters of the fatty acids were also obtained directly from the oil according to the standard method (A.O.A.C., 1965).

The solid (saturated) acid fraction and the liquid (unsaturated) acid fraction we.e subjected to reversed phase circular paper chromatography using Whatman No. 1 (chromatographic grade) filter paper impregnated with 40% liquid paraffin in benzene. The developing solvent system (mobile phase) was 90% acetic acid saturated with liquid paraffin. A solution of the fatty acids in acetone was used for spotting. The developed chromatogram after drying at room temperature, was dipped in dilute copper acetate (10 ml of saturated solution diluted to 250 ml) solution for 45 minutes, washed in running water for 1 hour, and then dipped in 0.4% solution of Sodium diethyl dithiocarbonate for 15 minutes, when concentric dark brown bands appeared. By carrying out co-chromatography with authentic samples the following fatty acids were detected : myristic, palmitic, stearic, arachidic (in traces) and behenic (in traces) in the solid saturated acid fraction and oleic and linoleic in the liquid (unsaturated) acid fraction.

The methyl esters of solid and liquid acid fractions and the mixed methyl esters prepared directly from the oil were analysed by gas-liquid chromatography using a F & M Model 1619 gas chromatograph with a stainless stell column (2.44 metres length; 0.63 cm int. dia) containing EGSS-X on chromosorb-W at 200°C isothermelly, using the Flame Ionisation Detector. Nitrogen was used as the carrier gas (flow rate : 60 ml/min). The peaks were indentified by comparison of their retention times with those of the methyl esters of authetic fatty acids, run under identical conditions. The relative percentages of acid, were computed by estimating

the area of individual peaks after triangualtion using the formula, peak height × width at half height. Relative percentage composition of the individual acids in the solid (saturated) acid fraction was : myristic 0.4%, palmitic 77.06%, stearic 20.6%, oleic and linoleic 0.93% each (as concomitants) The relative percentage composition of the individual acids in the liquid (unsaturated) acid fraction was : oleic 22.48%, linoleic 75% and palmitic 2.52% (as concomitant).

The percentage composition of the fatty acids of the seed kernel oil is as follows : myristic acid 0.2%, palmitic acid 21.3%, stearic acid 5.7%, oleic acid 16.23%, and linoleic acid 57.2%.

Judged from the above composition it appears that the *Bursera* seed kernel oil belong to the normal type of fatty oils. Though the general composition does not indicate any non-edible chracteristics yet the oil cannot be recommended for edible purposes at this stage, unless the edibility tests are also carried out. However, it can serve as a raw material for the soap industry like any other 'non-edible' oil.

Acknowledgement

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SUMMARY

***Bursera penicillata* (sny. *B. delpechiana*) commonly known as Indian Linaloe or Indian Lavender is an exotic, introduced into India, and is at present one of the most important essential oil yielding plants. The essential oil is obtained from the fruit husk and the seed as such has not been put to any use at present, although it is available to the extent of about 5 tonnes every year. An examination of the seed has shown that it contains a fatty oil (17–18% yield on the wt. of the whole seed) whose compostion has indicated that it belongs to the normal type of fatty oil. The oil is composed essentially of the glycerides of the following fatty acids : myristic, palmitic, stearic, oleic and linoleic. Its physico-chemical characteristics have also been determined. It can serve as a suitable raw material for the soap industry.**

बर्सेरा पेनिसिलियाटा के बीजों के वसायुक्त तेल का रासायनिक विश्लेषण

लेखक के०एस० त्यागराजन व वी०वी० प्रभु

सारांश

बर्सेरा पेनिसिलियाटा (पूर्व नाम ब० डेलपेकियाना) जिसे प्राय: भारतीय लाइनालो या भारतीय लैवेण्डर कहा जाता है, परदेशीय पादप है जिसे भारत में ले आया गया है और इस समय यह बहुत महत्वपूर्ण उत्पत तेल उत्पादक पादपों में से है। इसका उत्पत तेल फूलों की कलियों से प्राप्त होता है और इसीलिए अभी तक बीज को किसी उपयोग में नहीं लाया गया है यद्यपि यह प्रतिवर्ष लगभग 5 टन तक मिल जाता हे। बीज का

परीक्षण करने पर पता चला कि इसमें वसायुक्त तेल (पूरे बीज के भार से 17–18% प्राप्ति) होता है जिसके गठन से पता लगा कि यह सामान्य किस्म का वसायुक्त तेल होता है। यह तेल मुख्यतः निम्नलिखित वसायुक्त अम्लों के ग्लाइसेराइड्स से बना है :—माइरिस्टिक, पामीटिक, स्टीयरिक, आंलिक और लाइनोलिक। इसके भौतरासायनिक लक्षण भी विनिश्चित किये गये हैं। साबुन उद्योग के लिये यह उपयुक्त कच्चे माल का काम दे सकता है।

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RESEARCH NOTES

IN SITU DEVELOPMENT OF CALLUS SHOOTS IN SANDAL (*SANTALUM ALBUM* L.)

Sandal (*Santalum album* L.) of Santalaceae has been a subject of research since centuries. It has revealed several interesting phenomena and still remains an interesting species with regard to its vegetative reproduction. Recently, the State Forest Department undertook sandal tree extraction in the forests of G.K.V.K. campus, UAS, Bangalore. The actual sandal extraction involves digging about one foot depth around the collar region and disconnecting the main trunk from the side roots At this stage, the roots were left behind *in situ* and the dug up region was filled back with soil. After a period of 2-3 months it was observed that the cut ends of these roots had developed numerous clusters of whitish or pale yellowish and very brittle young shoots from the upper as well as lower sides of rootstocks. There were nearly five hundred such shoots growing up from a callus formation (Fig. 1).

The roots which had such clusters of young shoots were traced upto their ends and found that these young shoots were confined to the butt region only, and the rootstocks were found still in living condition having organic connection with the host roots through haustoria. It appeared as if that although the trunk was removed, the rootstocks that were left behind still retained an instinct to produce shoots. The more common feature observed in sandal is that the standing trees reproduce vegetatively by means of root suckers and the cut ends or the wounded and exposed roots produce a few shoots which will develop into green plants. On the other hand the shoots developed from the disconnected rootstocks produced callus from which hundreds of shoots sprout which remain whitish or yellow and gradually turn green after exposure to sunlight. The cambiun produces callus and the latter produces a number of shoot buds which pierce out of the root bark. Anatomy of such shoots revealed that they have a stele and a massive parenchymatous cortex filled with starch.

These achlorophyllous shoots were separated from the callus region and planted individually in separate polybags containing soil along with the host seedling namely *Cassia siamea*. They were kept in the mist chamber for two months. It was observed that each such individual shoot produced green shoots and a root system.

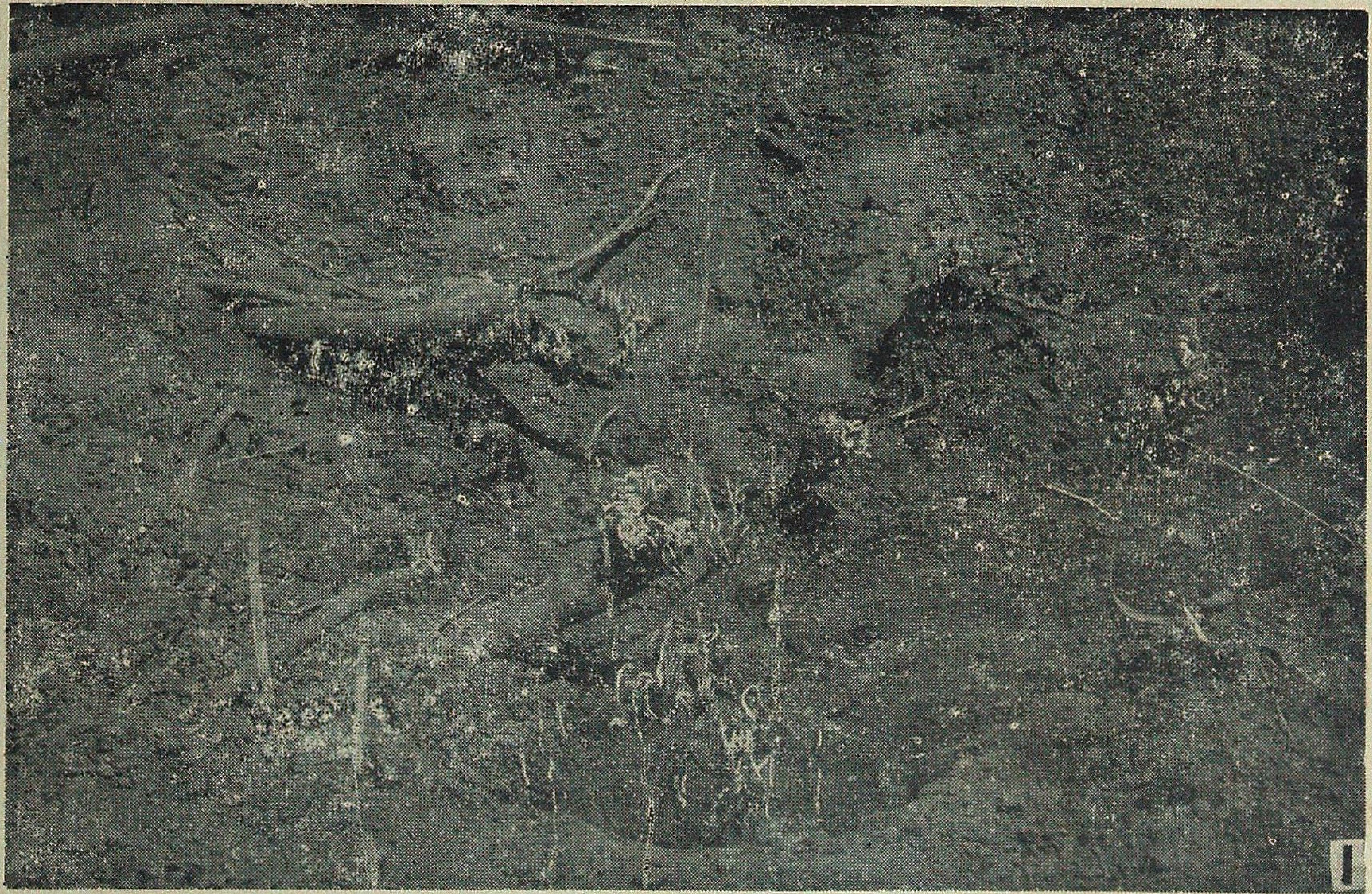
Achlorophyllous shoots were also subjected to growth regulator (NAA : 100, 200, 300 ppm) treatment. It indicated that hormonal treatment is not required as the shoots without treatment also developed the root system. Even after repeated trimming of the tender shoots from the callus region, fresh sprouts appeared.

The present study has, therefore, implied that the tissue culture propagation of sandal tree is not actually required for clonal propagation and tree improvement. In order to obtain the callus shoots from the live standing trees showing desirable characters it is just sufficient to disconnect one or two lateral roots which will induce the production of the callus shoots. This technique has very much simplified clonal propagation of the selected trees in sandal. It may be necessary to further study the growth performance, development of heartwood and flowering nature of plants developed by this technique.

Department of Farm Forestry,
University of Agricultural Sciences,
GKVK, Bangalore-560 065.

V. Bhaskar
and
N. Swamy Rao

Fig. 1



White callus shoots on the butt ends of a felled sandal tree.

Fig. 2

Established sandal seedlings with host, developed from callus shoots.

NEWS AND NOTES

DECLARATION OF THE XVII IUFRO WORLD CONGRESS

Research Today for Tomorrow's Forests

Considerations

Wood is the world's major renewable commodity and world demand for wood and other forest products and services is increasing with population growth and improved living standards.

There is a finite area of land in the world for the production of goods and services and the proportion available for forestry is steadily diminishing.

Unless appropriate measures are taken, increased exploitation will endanger not only the future supply of goods and services from the forest but also the forest gene resources, agricultural production, water resources and the human environment.

There is a considerable potential for increasing the productivity of forests and for integrating the various demands upon the land.

The distribution of forests in relation to human populations is unbalanced and there is an imperfect understanding of the ecology of both natural and man-made forests especially in some tropical regions.

Forest research is necessary to develop the forest potential, to overcome the constraints and difficulties and to alleviate the hunger, poverty and unemployment that are suffered by man in many regions.

Declaration

The priorities of research are to gain a fuller understanding of the ecology of the world's forests to increase their productivity both in quantity and quality and to improve conversion and utilization of forest products.

Inter-agency research into integrated land use should be encouraged, especially in tropical regions.

Forestry research should take account of the social, cultural, operational and economic factors in different regions.

There is a special need for research into the production of fuelwood in deforested regions and into the use of forest biomass for energy throughout the world.

There should always be close cooperation among policy makers, forest managers and research workers, both nationally and internationally, to ensure the formulation of realistic and productive research programmes and the effective implementation of research results.

In the face of financial stringency, governments and other supporting organizations should provide reasonable funding for forest research to enable forest research workers to make an effective contribution to human progress.

DIVISION 1—Forest Environment and Silviculture

Considerations

In order to increase production per unit area, methods are being applied and further developed, which concentrate too closely on the maximization of increment and yield and thereby threaten the stability of forest ecosystems ecologically and economically.

There is a tendency for silvicultural research and practice in natural and seminatural forests to be too closely oriented to agricultural techniques.

The results of research aimed at understanding or improving the various functions of forest simultaneoùsely, are not always sufficiently applied in practice.

Notwithstanding considerable activity in the field of agroforestry research and practice, particularly in the third-world countries, this kind of land use must be better understood so that agroforestry practices can be introduced more rapidly to suitable regions of the world.

The extent of deforestation is becoming very serious, whereas the rate of afforestation is inadequate.

Insufficient consideration is given to research into trees and small plantations in urban areas and outside the forest.

Recommendations

The methods and techniques of creating, maintaining and improving forest ecosystems, as developed in temperate and boreal zones, need to be further improved and tested before being applied to other forest ecosystems, in particular in tropical and subtropical climates.

Silvicultural practice and research must be related to the natural processes in the forest.

There is a need to improve the dissemination of results of silvicultural research by extension services, and by training and education.

Research on agroforestry should be intensified. However, this can only be done successfully if

—there is close cooperation with other land-use specialists such as agriculturists and horticulturists, and

—relevant basic research is included in cooperation with other relevant international institutions.

There is a need for further research into the suitability of land for afforestation. This includes classification of the site, as well as research into the requirements of trees. Moreover, afforestation techniques need to be further developed.

Arboriculture and related research need to be further developed.

DIVISION 2—Forest Plants and Forest Protection

Considerations

Rapidly expanding forestry operations in tropical and subtropical areas commonly deploy species on a very large scale, decreasing the extent of indigenous and undisturbed forest ecosystems and leading to loss of genetic resources as forest populations are removed. Such forestry is often likely to be adversely affected by poorly known pests and diseases, although resistance of plants and plant communities to biotic damaging agents is the rule, not the exception.

Integrated pest management is the most effective way of combatting damaging agents but integrated approaches to forest protection are at the present, rarely adapted.

Traditional research on existing resources and commercial plantations will continue to be needed but more emphasis is required on the contribution of trees and forest to rural development.

With limited financial means, funding of basic research in forestry is being reduced particularly in the fields of physiology and genetics. The temptation to abandon research that is not immediately applicable should be resisted in the long-term interest of forestry.

There should be an increase in the support for gene conservation activities and the need for such measures must be considered and appropriate action taken at all levels wherever forests are used.

Sufficient ecosystems of special interest, particularly in the tropics, should be preserved so that all interacting organisms can continue to co-evolve and remain available for study.

Study of the genetics of interactions between trees and agents in the field of entomology and pathology are urgent and should be encouraged.

Genetic resistance should be incorporated into integrated pest management systems whenever favourable results may be expected.

Agencies should be alerted to the danger that well intended actions to ensure excellence of cultivars may narrow the genetic base and reduce variability vital for the stability and resilience of the forest.

Research-supporting agencies should keep an adequate balance between funding for basic and applied research.

DIVISION 3 – Forest Operations and Techniques

Considerations

All forest operations, and particularly those relating to three harvesting and stand establishment, must be planned and executed in a manner that will avoid unnecessary conflict.

It is necessary to deal with all the aspects of forest labour and particularly employment factors, work environment conditions, and reduction of the more arduous aspects of forest work.

Forest operations must be adaptable to the specific technical and biological conditions which exist in the forest.

Technical and biological considerations are influenced by a wide variety of terrain, (i.e. slope, ground roughness and ground strength) climate and stand conditions.

Recommendations

Increased research is needed with regard to integrating forest operations as a whole in order to find the best compromise for social, silvicultural, technical and economic consequences.

Research dealing with the labour aspects of forest operations must continue with particular emphasis on ergonomics, a safe working environment and training at all levels of forest work with the objective of improving conditions that will provide a better work place for forest workers.

Research should lead to the production of increased volumes of industrial wood and fuel wood from individual trees as well as from the existing forest land base and from additional areas.

Research is needed to adapt operational techniques to the variety of conditions imposed by terrain, climate, silvicultural and socio-economic factors.

Special attention should be given to the requirements for research of particular value to forest operations in developing countries.

DIVISION 4 – Planning, Economics, Growth and Yield, Management and Policy

At the XVII IUFRO World Congress in Kyoto, Japan, in 1981 a number of considerations and recommendations concerning the works of Division 4 were formulated. They form the base of the work of the upcoming period 1982-1986. Four major topics are of main interest here.

1. Strengthening integrated research in the fields of forest inventory, forest management and yield on a world-wide scale.

To realise this goal a number of new working parties have been established within the subject groups S4.01-00, S4.02-00, S4.04-00 and cooperation among Divisions 4 and 6 has been intensified. In collaboration with national and international bodies (FAO, Society of American Foresters) a number of meetings will be arranged dealing especially with the following topics :

—directing and interpreting permanent yield science experiments,
– growth simulation of single trees and stands,
—promoting inventories in arid and humid forests in tropical and subtropical countries,
—studying ecosystems by inventories,
—formulating information needs for forest policy and management to adjust inventory methods,
—research on a permanent world-wide inventory for monitoring changes in the vegetational cover.

2. Intensifying research for increasing the output of goods and services from small private and community owned forests.

For better understanding the specific management conditions of these ownership categories a new working party has been created. In collaboration with S4.05-00 and P4.09-0J special emphasis will be put on the question of the effects of forests policy on the supply of timber from these ownership categories, on the comparative analysis of forest legislation and extension as a means of forest policy.

3. Analysis of the biological technical and economic effects of thinning.

In close cooperation with Division 3 coordinated efforts will be undertaken to study the effects mentioned above and to exchange knowledge in this field of research by meetings 1982-1986.

4. Quantifying the economic effects of multiple use forestry.

Ample attention will be given on the estimation of future resource values of forest as well as on evaluation methods for multiple use forestry. Closer cooperation with Division 6 is agreed on and will be executed by joint meetings.

DIVISION 5—Forest Products

1. Division Objectives

The demand of the increasing world population have begun to exceed the productive capacity of existing forest systems. Consequently the aim of the Division's activities is to increase :

– the efficiency of precessing forest resources,
—the effectiveness of utilization of forest products.
—the cooperation with forest growers so that their practices produce the greatest volume of wood (and similar materials) with the highest quality.

Increasingly the interest of Division 5 will be concerned with the utilization of the timber resources of the next decade. Industrial wood will be obtained more and more from fast-grown, short-rotation plantations of a limited number of species, that will be utilized more completely than previously. The properties, conversion and treatment of these woods have received relatively little attention. The information will be vital for the increased efficiency and integration of the forest products industry.

The properties and utilization of future supplies of non-industrial wood for firewood in peasant communities has not yet received active study. It is one of the most urgent problems of lesser development countries.

2. *Operational Program*

* All-Division 5 Conference

This will be held at the Forest Products Laboratory, Madison, Wisconsin, USA, June 27 to July 5, 1983 with the theme Fast Growth : Greater Utilization. It will be held in association with the Annual Meeting of the Forest Products Research Society at Norfolk, Virginia, USA, during June 19 - 23, 1983. It is likely two other international bodies will integrate their activities with the Division 5 Conference.

* International activities

—proposed Conference with Division 1, 2, 3.

The features and properties of the juvenile wood of fast-growing species should be determined.

There is a need for increased research into the classification of the wide range of species into a small number of end-use categories so that the use of wood is matched to its properties rather than its botanical identity.

The efficiency of forest utilization should be increased through greater conversion of the tree to a range of products, preservation of the products to ensure longer use and the development of structural designs to use the products more efficiently.

High priority should be given to the research and development of efficient conversion of wood to energy by the efficient use of solid wood in simple stoves and industrial boilers as well as conversion to gaseous and liquid fuels.

DIVISION 6—General Subjects

Considerations

There is an increasing pressure on the land in many areas and a growing need to land-use planning.

The sun of knowledge is increasing at an accelerating rate. This knowledge has continually to be communicated to foresters in the field.

Forest history can make a valuable contribution to a better understanding of the various factors involved in the development process. There has, up to now, been relatively little activity in this area.

Mini-and micro-computers will play an increasing role in the processing of research data.

Most of the research projects in forestry have a practical aim.

The recreational possibilities of forests will become increasingly important in the developed countries.

Recommendations

Efforts should be made to support a continual flow of satellite digital earth resources data to all countries of the world without security restrictions.

Existing information services should be promoted and new services established, to keep pace with research activities in general.

Research into forest history should be increased.

Forest research projects should include provision for the practical application of the results of the research.

Multiple use of the forests, necessitates a multidisciplinary research approach

(Reproduced from IUFRO News No 37, 1982)

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GAZETTE NOTIFICATIONS

F.R.I. GAZETTE

The President, Forest Research Institute & Colleges, Dehra Dun has beed pleased to appoint Shri S.S. Pani, Office Superintendent, to the post of Assistant Registrar on ad-hoc basis w.e.f. 4.11.1982 (F.N.) and on regular basis w.e.f. 22.11.1982 until further orders.

KARNATAKA GAZETTE

Shri S.C. Thippeswamy, IFS., Joint Managing Director, (Rubber) Karnataka Forest Plantation Corporation Limited, Mangalore is promoted to officiate in the super time scale of the Indian Forest Services viz., 2500-125/2-2750 and his services are continued to be placed until further orders at the disposal of the Food and Forest Department for appointment as Managing Director Karnataka State Forest Industries Corporation Limited, Bangalore, vice Shri S.N. Krishna Murthy retired.

U.P. GAZETTE

Shri Hari Kant, Conservator of Forests, Working Plan Circle–I, U.P., Nainital is transfered with immediate effect in the interest of public service as Regional Director, Social Forestry, Avadh Region, Lucknow vice Shri K B. Srivastava.

Consequent on retirement of Shri Jaswant Singh, Conservator of Forests on 31-1-1983, the following Conservator of Forests are posted and transfered with immediate effect in the interest of public service :

1. Shri Ved Pal Singh Verma, Conservator of Forests, Timber Supply Circle, U.P., Nainital is posted as Conservator of Forests, Garhwal Circle, Pauri vice Shri Rameshwar Sahai Mathur. Shri Verma will hand over the charge of Timber Supply Circle to Shri Y.C. Rai, Conservator of Forests, Utilization Circle and then proceed to his transfer. Shri Yatish Chandra Rai will take over the additional charge of Timber Supply Circle until further orders.
2. Shri Rameshwar Sahai Mathur, Conservator of Forests Garhwal Circle, Pauri is posted as Conservator of Forests, Kumaon Circle, Nainital vice Shri Hira Ballabh Joshi. Shri Mathur will hand over the charge of Garhwal Circle to Shri V.P.S. Verma and then proceed to his transfer.
3. Shri Hira Ballabh Joshi, Conservator of Forests, Kumaon Circle, Nainital is posted as Conservator of Forests, Shiwalik Circle, Dehra Dun vice Shri Jaswant Singh. Shri Hira Ballabh Joshi, will immediately hand over his charge to Shri D P. Gupta, Conservator of Forests, Western Circle, Nainital and then proceed to his transfer so that he should relieve Shri Jaswant Singh on 31-1-1983 (A.N.). Shri D.P. Gupta will continue to hold the additional charge of Kumaon Circle, Nainital till Shri R.S. Mathur joins.

The following Deputy Conservator of Forests are promoted to the Conservator of Forests from the date of assumption of their charge in the interest of public service and posted as under : –

Sl. No.	Name and Present Post	Post under which Promoted	Remarks
1.	Shri Chandra Gupta Director, Social Forestry, Etawa	Conservator of Forests, Tehri Dam Cricle, (Newly created post)	Shri Chandra Gupta will continue to hold the additional charge of Divisional Director, Etawa until further orders.
2.	Shri Hem Chandra Joshi Dy. Conservator of Forests, Haldwani Forest Division, Haldwani.	Conservator of Forests, Working Plan Circle-I, U.P., Nainital.	Shri Hem Chandra Joshi will hold the charge of Haldwani Forest Division, Haldwani in addition to Conservator of Forests, Working Plan Circle-I, Nainital till further orders.
3.	Shri Jitendra Nath Srivastava Dy. Conservator of Forests, North Gonda Forest Division, Gonda.	Joint Director, Statistical and Evaluation Unit, Social Forestry Directorate, Lucknow.	Under Office Order No. 2939/14.4.82—607/81 Shri Jitendra Nath Srivastava will remain to hold the additional charge of North Gonda Forest Division, Gonda until further orders.

———

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Indian Forest Records

Vol. 14, No. 2—*Entomology* : Revision of termite genus Odontotermes Holmgren (Isoptera : Termitidae : Macrotermitinae) from India, by M.L. Thakur. PFRI. 23. XIV. 2.
Rs. 40.00 or £ 5.00 or $ 15.00.

Other Publications

Troup's—The Silviculture of Indian Trees, Vol. II—Dipterocarpaceae Revised and enlarged by H.B. Joshi. PFRI. 170. Rs. 41.50 or £ 4.85 or $ 14.95.

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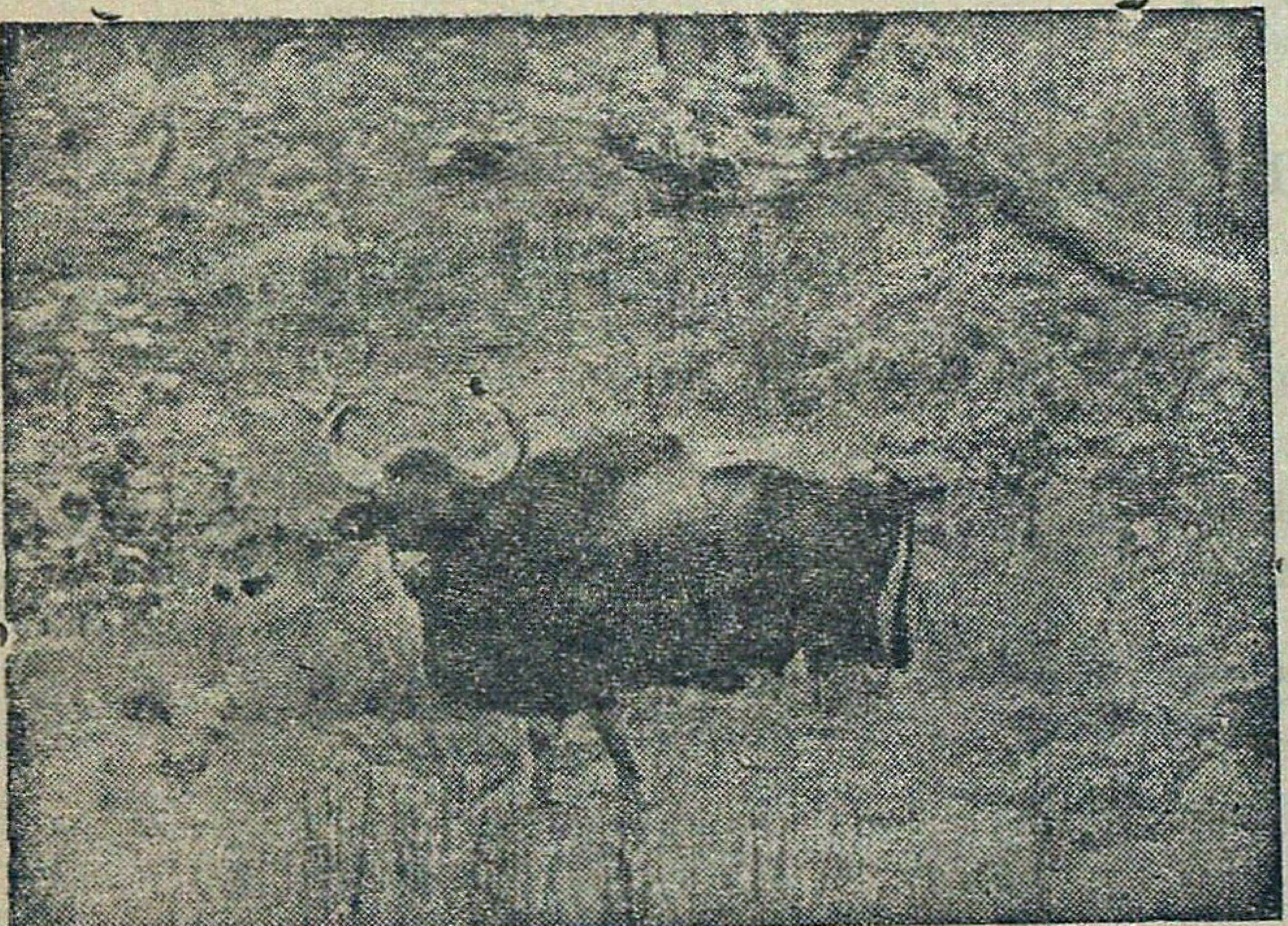

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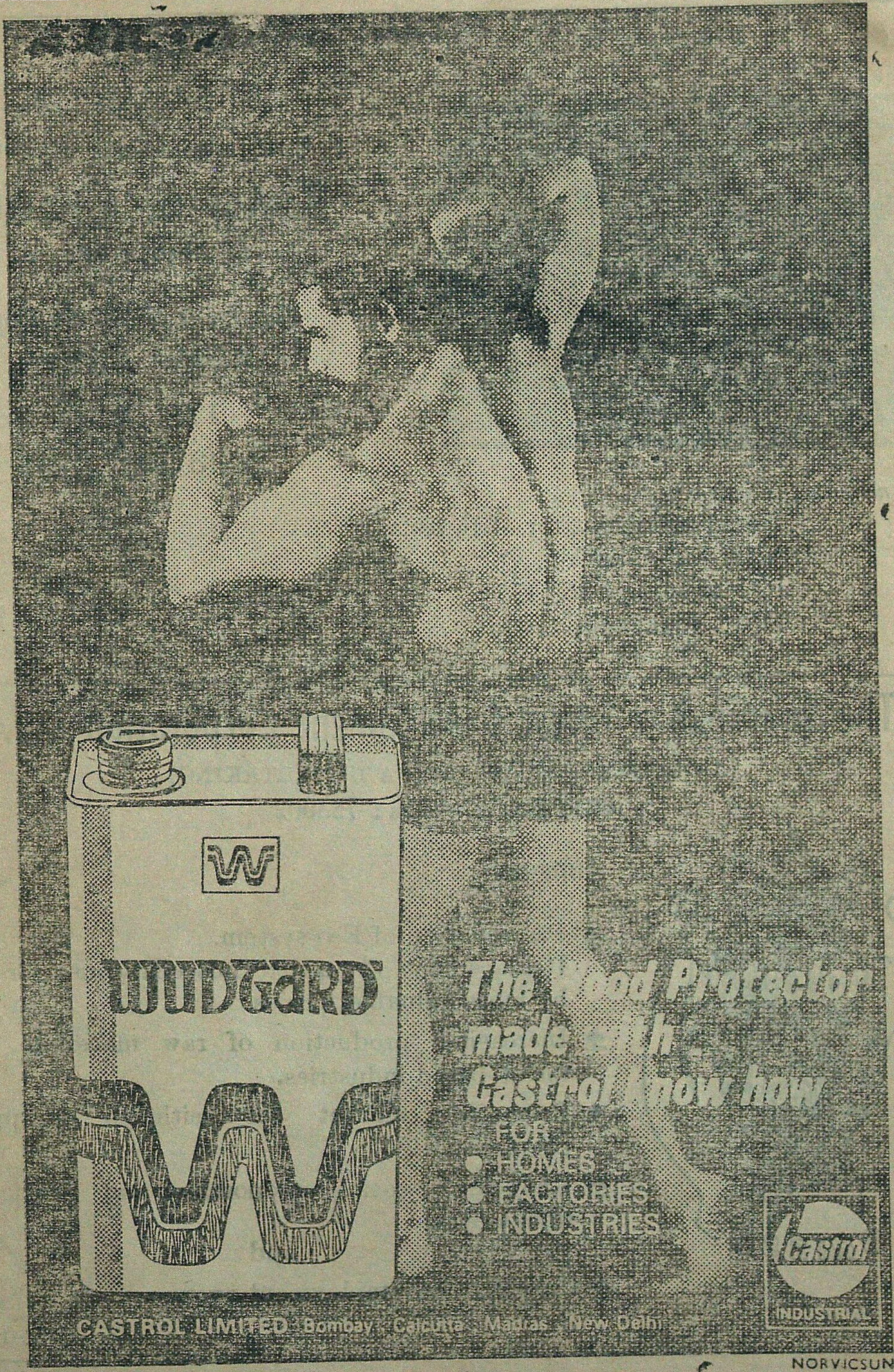
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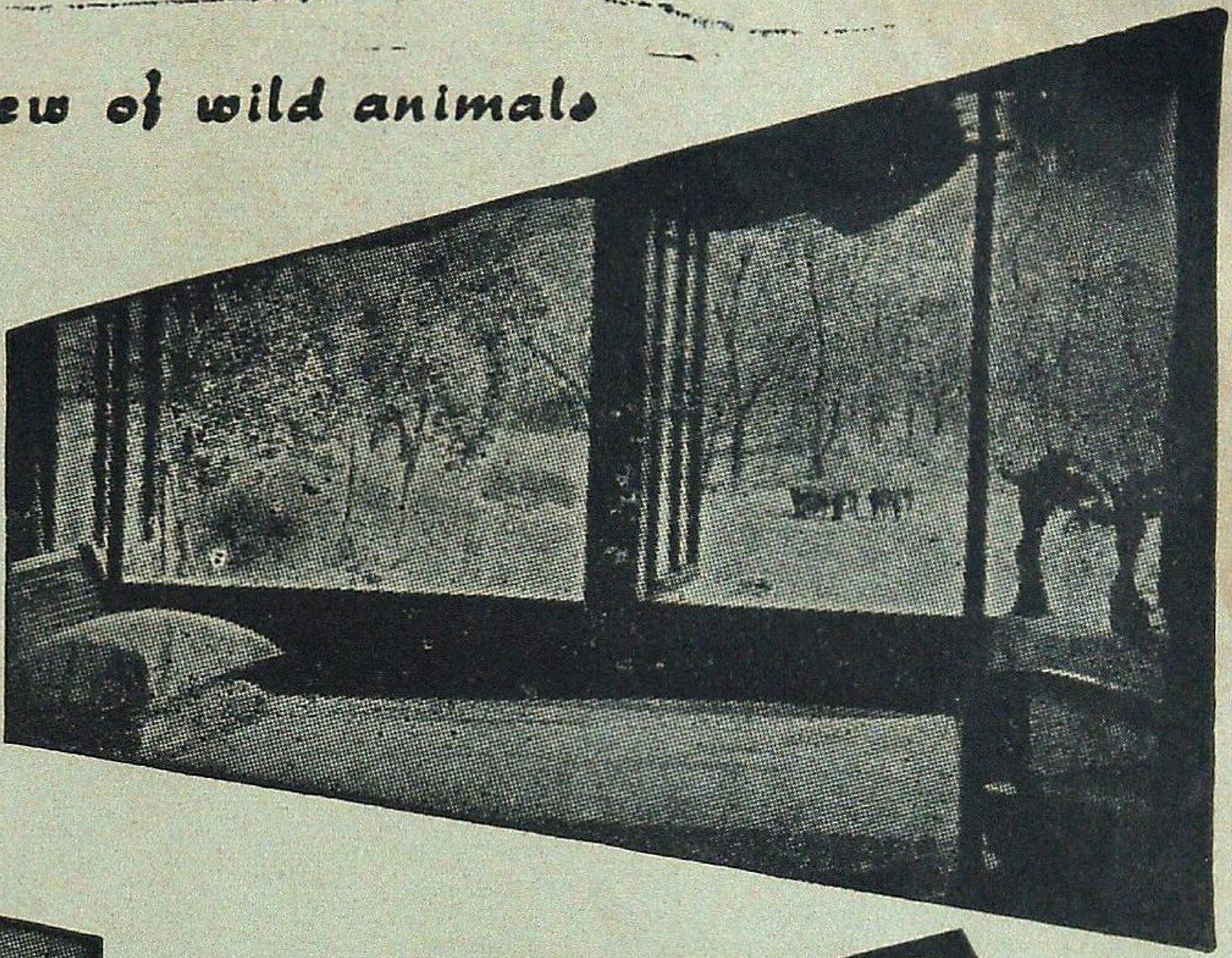

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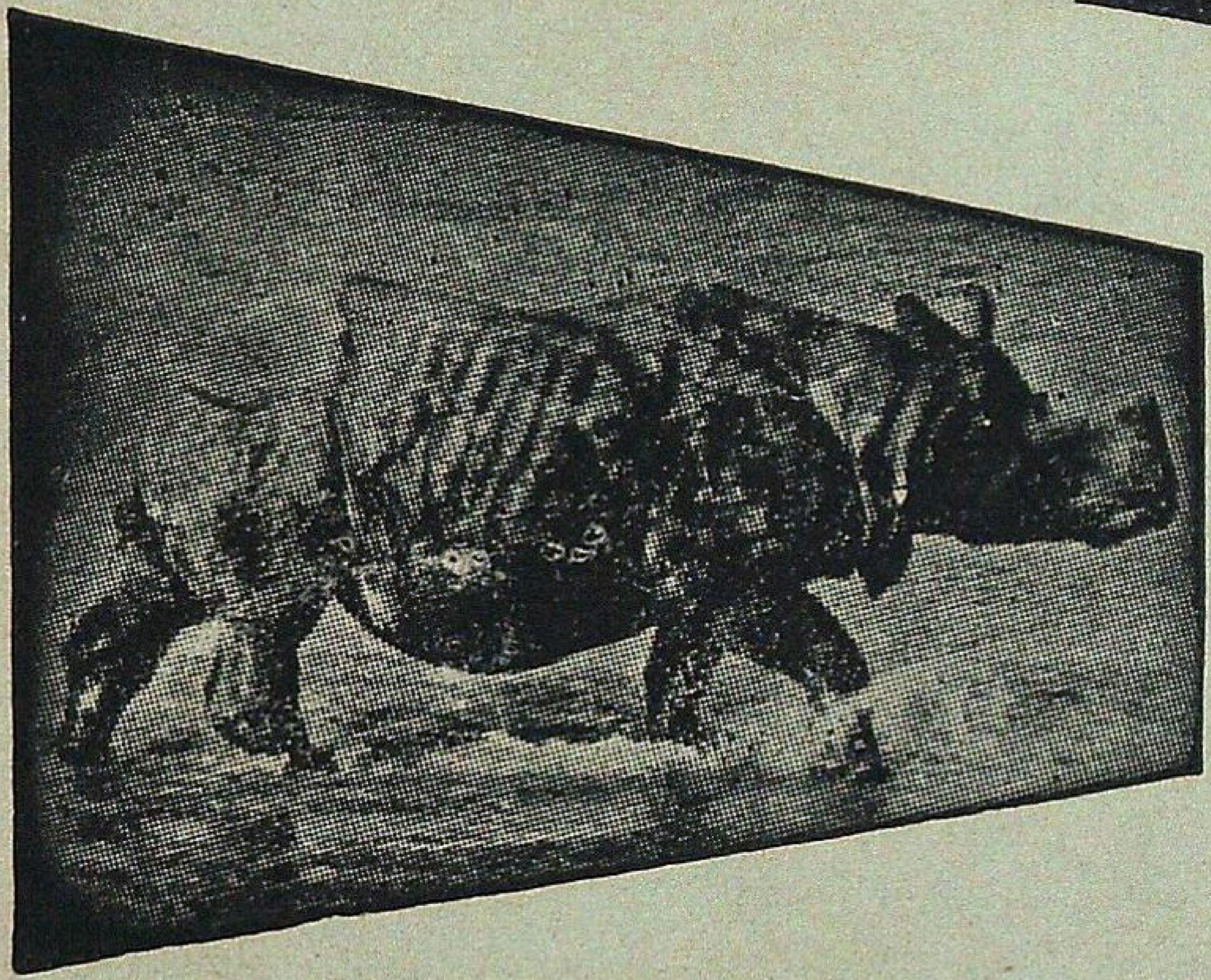

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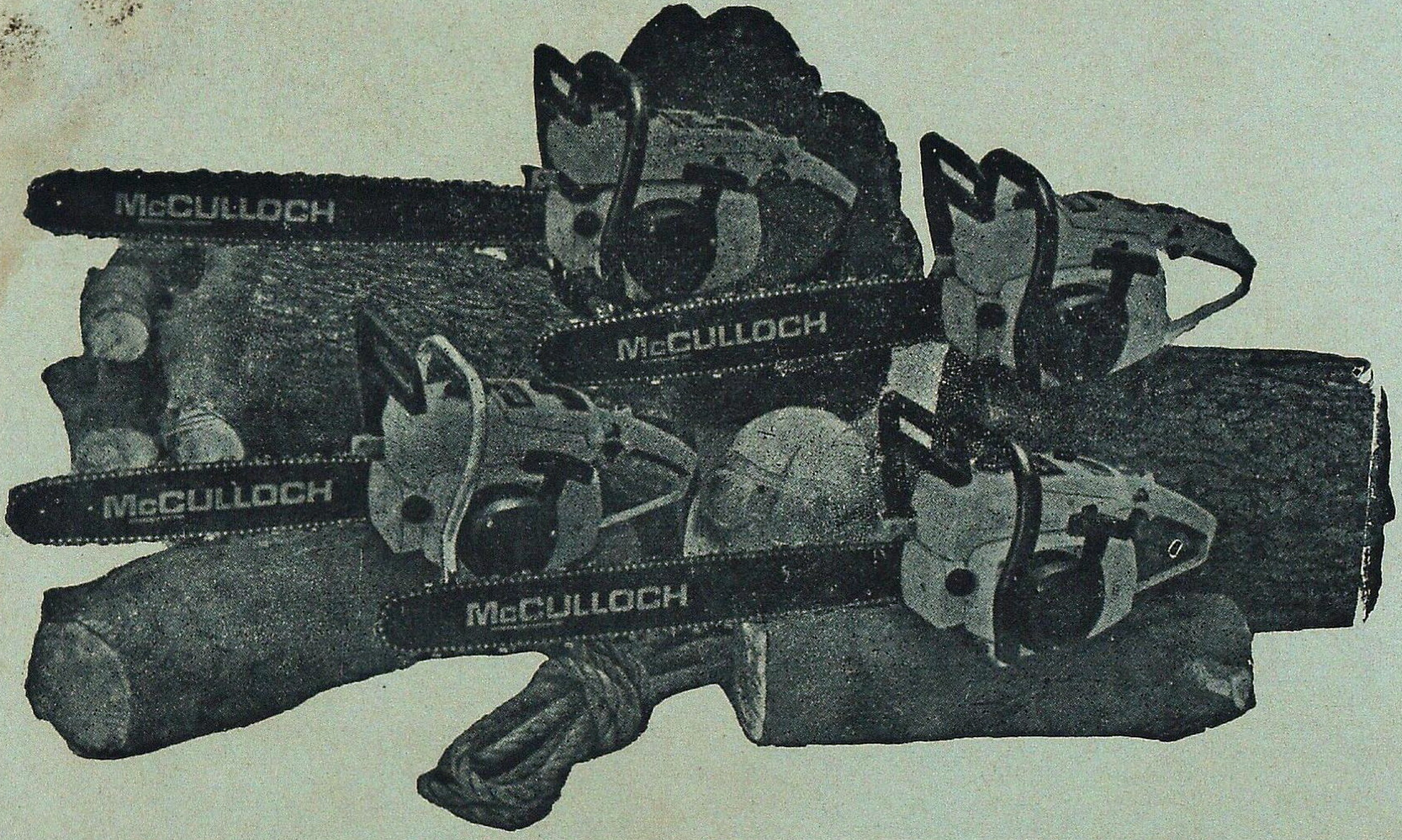

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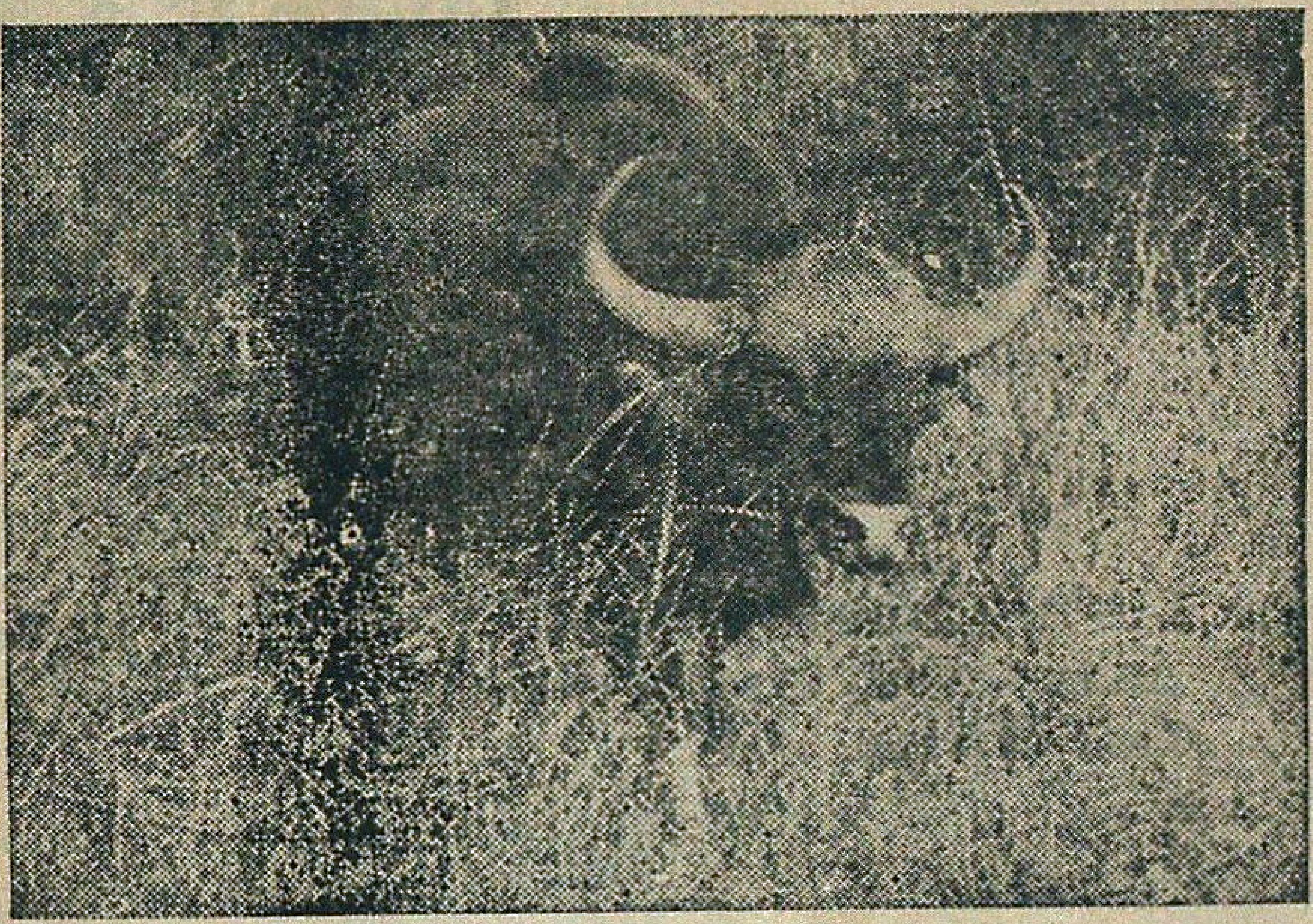

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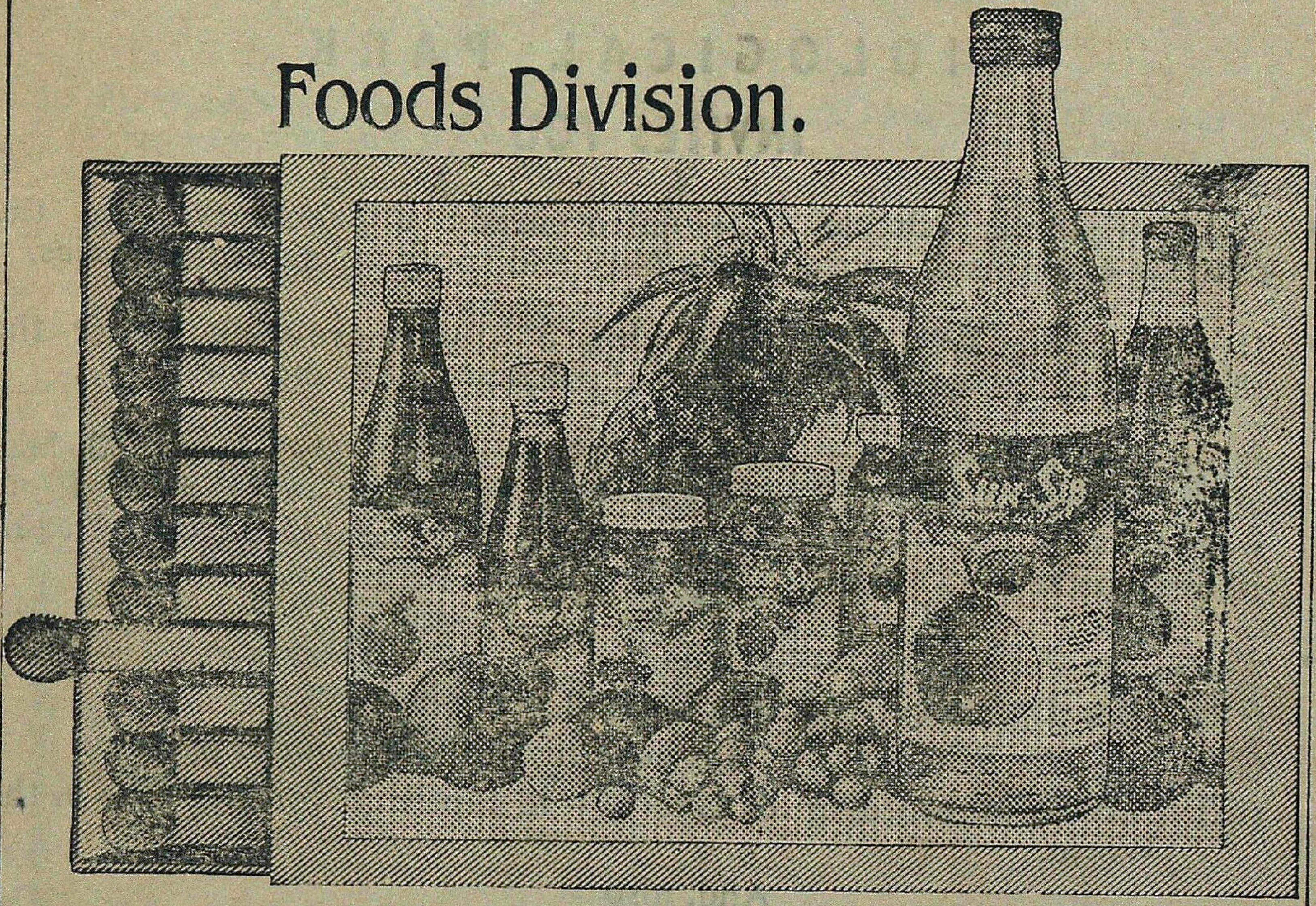

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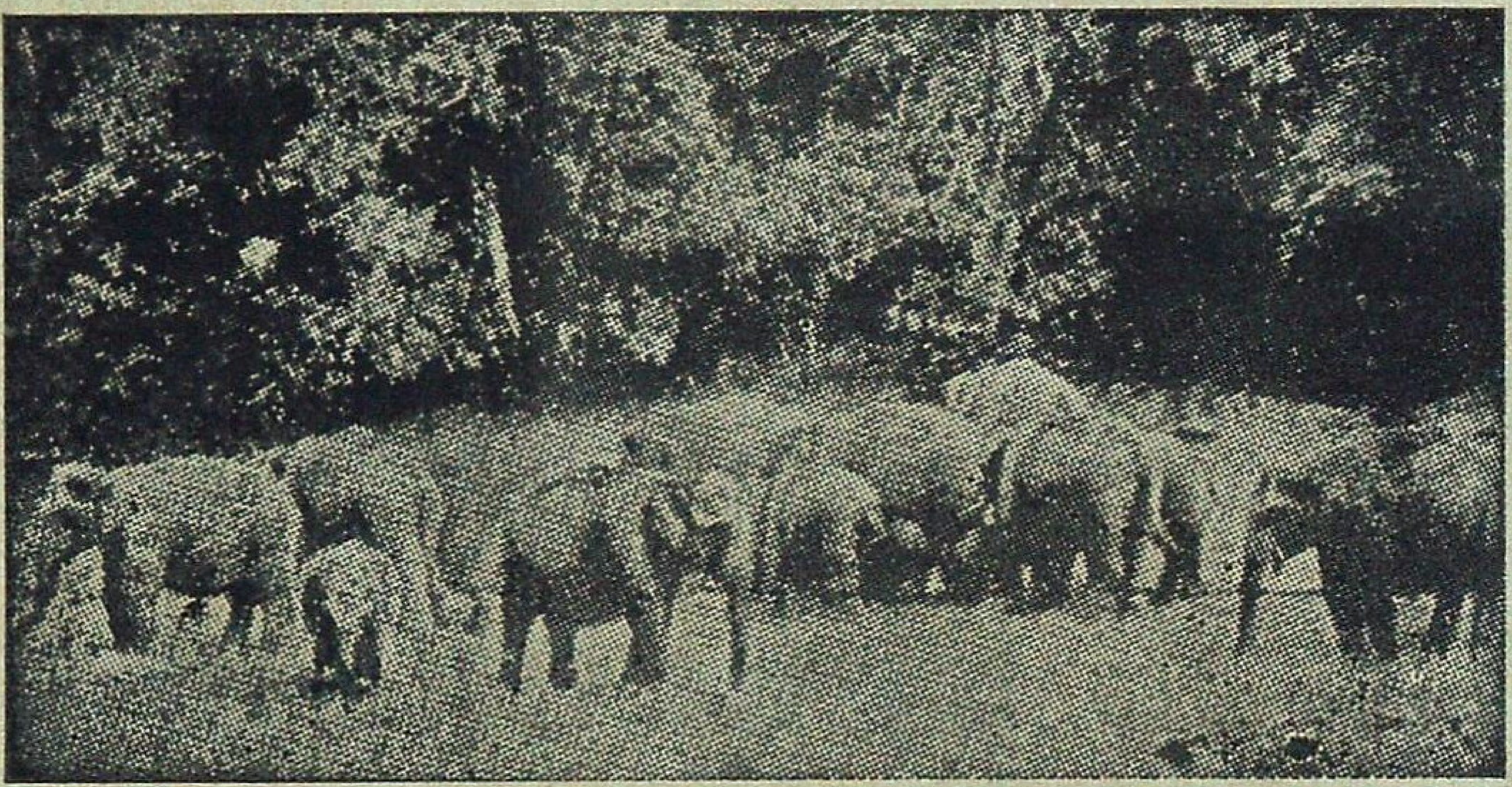

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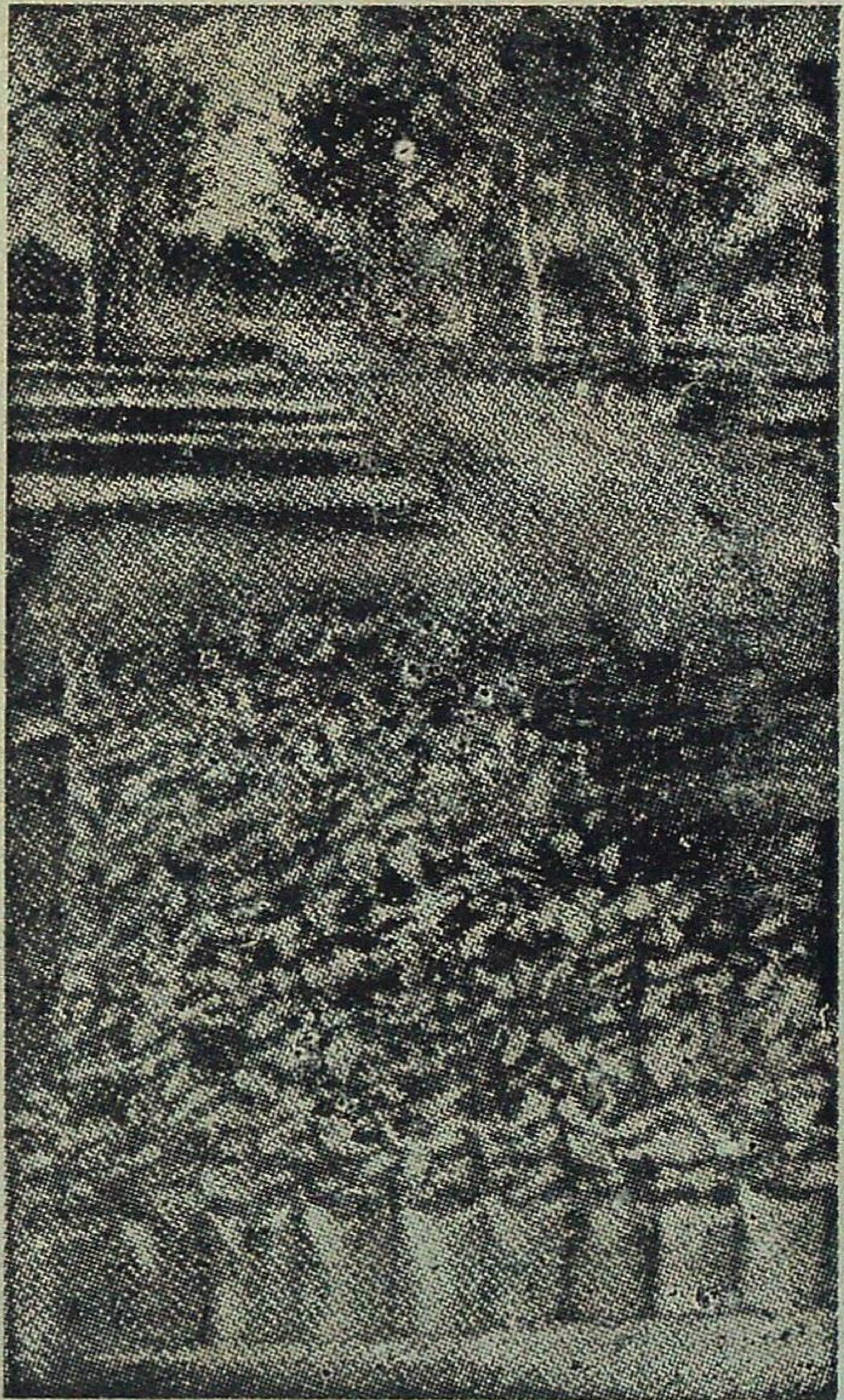

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THE

INDIAN FORESTER

VOLUME 109 JANUARY, 1983 NUMBER 1

FINE GROWTH OF *TERMINALIA ARJUNA* (ARJUN) RAISED TO INTRODUCE TASSAR CULTURE UNDER SOCIAL FORESTRY PROGRAMME AT CHANDRAWAL NURSERY, SITAPUR, UTTAR PRADESH. Photo—M.M. Bahukhandi ... Front Cover

CONTENTS

EDITORIAL

ARTICLES

FORESTRY FOR THE RURAL POOR. K.M. Tiwari 1

GROWTH OF *LEUCAENA LEUCOCEPHALA*. A.N. Chaturvedi 7

A NOTE ON THE *PAULOWNIA* TRIALS—FUTURE HOPE FOR SOCIAL FORESTRY. V.R. Neelay and A.K. Sah 10

EFFECTS OF SPACING AND THINNINGS IN *CASUARINA* STANDS. S.P. Singh, R.S. Sharma and R.C. Jain 12

NUTRIENTS COMPOSITION OF SOME FODDER TREE LEAVES AVAILABLE IN SUB-MOUNTAINOUS REGION OF HIMACHAL PRADESH. Vinod Khatta and B.S. Katoch 17

PERFORMANCE OF *DIOSCOREA FLORIBUNDA* MART AND GAL AT SEPAHIJALA, TRIPURA. B.N. Saha, D.N. Bordoloi and D. Ganguli 25

PROVENANCE—RELATED GROWTH RESPONSE OF *POPULUS CILIATA* WALL. EX ROYLE TO NITROGEN FERTILIZATION. G.S. Deol and P.K. Khosla 33

CHEMICAL INVESTIGATION OF FATTY OIL OF *BURSERA PENICILLATA* SEED. Theagarajan and V.V. rabhu 41

RESEARCH NOTE 45

NEWS AND NOTES 47

GAZETTE NOTIFICATIONS i

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